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THE INCOMPLETENESS OF OUR KNOWLEDGE OF HEREDITY IN MAMMALS

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Several years ago T. H. Morgan wrote, "The problem of heredity is solved." This statement was made in connection with an exposition of the chromosome theory of heredity. About the same time the late William Bateson, an equally distinguished student of heredity, the founder of genetics, in an address at Toronto, expressed the view that our present knowledge of heredity is so imperfect that it gives no clew as to the method by which evolution takes place. I am inclined to agree with Bateson rather than Morgan in this matter.

No one familiar with examples of Mendelian inheritance can doubt the fundamental importance of Mendel's law in the production of new breeds of domestic animals and of new varieties of cultivated plants. The law is equally operative among animals and plants in a state of nature—i.e., when they are not directly under the control of man; yet natural selection in the wild state tends strongly to limit the propagation of unusual and abnormal types, which by man are frequently given preference.

The marvelous variation of our domestic mammals in color and other characters of the coat is due to mutation in a relatively small number of genes borne in the chromosomes of the germ cells. The change from a wild-type coat (gray) to an all black coat is due to a regressive mutation in a single chromosomal gene. Such a unit character change is found in our black varieties of rabbits, mice, rats, guinea pigs, dogs, cats, sheep, swine, cattle, and horses. Yellow varieties originate by mutation in another gene regularly borne in a different chromosome. Albino and

albinistic varieties arise by regressive mutation in a third gene, the so-called color gene, regularly borne in a third chromosome. Mutation in a fourth gene may change black pigment to chocolate brown throughout the body. This has occurred in rabbits, guinea pigs, mice, dogs, and horses. Undoubtedly a gene capable of regressive mutation from black to brown is present in all mammals. It can only be regarded as an accident that the brown mutation has, up to this time, failed to occur or to be observed in other domestic mammals. Mutations resulting in color patterns due to white spotting are found in wild mammals as well as in tame ones and are shown by genetic study to be the consequence, in every case, of mutation in a chromosomal gene.

Structural changes in the coat also result from single gene mutations. Such is the angora or long-haired mutation of rabbits, guinea pigs, cats, and goats. A single gene mutation in the rabbit produces a short-haired plush-like coat known as rex.

Mutations such as those mentioned, when combined in various ways, constitute the more striking differentials of numerous breeds of live stock. But they are not the sort of differentials that separate the species and subspecies of mammals in the wild state.

Consider, for example, the differences between the species and subspecies of *Peromyscus*, our commonest North American wild rodent. All have the same wild type of coat, and no unit-character differences between them could be discovered by Sumner in his many years of intensive genetic study of the problem. A subspecific cross made by him resulted in the production of intermediates as regards all differential characters. No unit-character segregation occurred in F_2. At first he rejected a Mendelian interpretation altogether, but in view of the increasing prestige of Mendelism and its general acceptance, he finally, with some hesitation, adopted a polymeric or multiple factor interpretation. According to this view, each character difference is the result not of mutation in a single gene but of mutation in several independent genes, the action of which is cumulative. Consequently the inheritance is blending. It is not to be supposed, on this hypothesis, that the mutations in polymeric genes all occurred simultaneously, so that subspecific differences arose suddenly. They may have occurred one at a time, so that the evolution of subspecific differences was a slow and seemingly gradual process, impossible without a certain amount of geographic isolation.

I may say that I am not at all satisfied as to the validity of the multiple factor Mendelian interpretation of blending inheritance. Its

correctness has never been demonstrated by any critical experiment. It was put forward as an attempt to universalize Mendelism, to bring all heredity into the category of gene inheritance. It was first suggested by Nilsson-Ehle to explain peculiar inheritance ratios in wheat, where it appeared that the dominant character was borne not by a single chromosome but by two or three different ones. It has since been demonstrated that cultivated wheat is a polyploid species, a situation which would allow of the existence of three or four sets of homologous chromosomes. A like mutation in an homologous gene of three homologous chromosomes would result in trihybrid inheritance ratios such as Nilsson-Ehle reported. The inheritance in this case was not blending, but the multiple factor interpretation was promptly extended to cases of blending inheritance in animals and plants, on the assumption (1) that dominance did not occur in such cases and (2) that the several independently inherited genes had cumulative effects.

The multiple factor hypothesis, in my opinion, remains an hypothesis merely, though I have given many years of intensive study to experimental tests of its validity.

Sumner did discover unit-character mutations occurring in wild *Peromyscus*, such as albinism, yellow coat, and hairlessness, comparable with the conditions known in laboratory mice and rats. The inheritance in such cases was typically Mendelian, not blending. But no such Mendelizing mutant characters occurred as species or subspecies differentials. Hence we must conclude that species in *Peromyscus* do not arise by the process of unit-character mutation.

Yet there can be no doubt that species characters are inherited. How closely similar the individuals of a wild species are to each other and to their parents. They seem to be replicas of each other, a result which can be ascribed solely to heredity, since Sumner has shown that transfer of a wild species of *Peromyscus* from its natural environment to the laboratory for a series of a dozen generations affects its general and distinctive characters not in the slightest.

I maintain, therefore, as many others have previously maintained, that the demonstrably Mendelian unit-characters of animals are relatively special and superficial in nature, whereas the more general and fundamental characters, though equally subject to heredity, are not inherited through the mechanism of chromosomal genes.

Take, for example, the case of the domestic rabbit, which I suppose has been studied, as regards its heredity, as exhaustively as any mammal. There have been demonstrated by critical study sixteen different unit-

characters in the rabbit, each due undoubtedly to a different chromosomal gene. Nine of these affect the color of the coat; five affect the structure of the hair (long hair, short hair, furless). One has to do with the color of the fat stored in various parts of the body, and one concerns agglutinogens carried by the red blood corpuscles, which form a basis for the recognition of four blood groups.

It will be observed that 14 of the known 16 genes of the rabbit affect details of structure or pigmentation of the hair, hair being a special character of mammals. Fat color (yellow or white) is due to a slight difference in the metabolism of fat storage from foods containing chlorophyl or carotene. Presence or absence of a hæmagglutinogen is a detail of composition of the red blood cells of immaterial consequence to the life of the rabbit, since rabbits of all blood groups are equally vigorous and occur both in the wild state and in domestication. It appears, then, that so far as our knowledge of the rabbit goes, character differences determined by chromosomal genes are special or inconsequential. No genes are known which, by mutation, would change a rabbit into something different from a rabbit, which would take it out of its genus, or class, or phylum. Such mutations do not occur, and we know nothing about the inheritance of these more general features of organization, yet inherited features they certainly are. The current theory of the gene assumes that these characters, as well as the more special known unit-characters, are influenced by chromosomal genes. But this is purely speculative. No direct evidence can be cited in its support, for no crosses can be made between animals which have and those which have not these general characteristics, and that is the only method of Mendelian analysis.

Genetics accordingly can not solve the problem of evolution, which involves changes in organization more general and fundamental in character—but probably slower and more gradual in becoming established—than those controlled by chromosomal genes.

One of the characters in which wild species differ is body size, and I have for many years been engaged in a study of its inheritance, both in a cross of a wild species of cavy with its supposed derivative, the domestic guinea pig, and in crosses of a very small-bodied race of rabbit with a very large-bodied race. The results are similar in both cases, but have been carried farther in the rabbit cross. The Polish rabbit weighs about 1500 grams (2–3 lbs.), the Checkered Giant weighs about 6000 grams (over 12 lbs.). One is thus four or five times as heavy as the other. A cross between the two produces animals of intermediate size,

and a second generation is also intermediate but slightly more variable. From the difference in variability in the two generations, we should, on a multiple factor Mendelian interpretation, have to assume the existence of numerous genes influencing size, genes located in practically all chromosomes. To test the hypothesis that chromosomal genes were concerned in determining the size difference, I crossed individuals of the two races which had four chromosomes tagged with dominant color characters in the large race and recessives in the small race. It was assumed that if genes affecting body size were borne in these four chromosomes, a difference in size should be found in F_2 between the animals which possessed the four dominant color characters and those which possessed the four recessives. No such difference was found in a population of several hundred back cross individuals. Consequently we may conclude that chromosomal genes are not primarily responsible for racial size differences.

We next turned to a study of the embryology of the large and small races. The eggs of the large and of the small races were indistinguishable in size or otherwise, but we found that the large race egg developed faster and produced a larger mass of tissue from which a larger embryo arose. Gestation is of similar duration in both races, and the young are born in the same stage of development in both, but the large race young are nearly twice as heavy. They also grow faster after birth and continue to grow for a longer time than the small race young. Consequently they attain a much greater adult size.

With increase in size of body in a mammal there is a change in body proportions, the skull and legs becoming longer in relation to their width, because growth takes place faster in length than in width of elongated organs. Thus the large race rabbit has a more slender skull and relatively longer legs, ears, and tail than small race rabbits.

The multiple gene theory assumes that the size of each part is determined by numerous genes and consequently that in crosses between races widely different in size, inharmonious combinations may arise, such as long legs on small bodies or vice versa. In our rabbit crosses nothing of the kind is observed, and we are now in a position to understand why this is so. The size of each part is not independently determined by numerous genes. All that we need assume to be predetermined is the rate of development of the fertilized egg. The size of the rabbit which results and the proportions of its parts follow as necessary consequences of rate of development.

Accordingly we find the theory that chromosomal genes account for

the whole of heredity inadequate to explain the inheritance of racial differences in body size. And it is equally inadequate to explain the inheritance of other characters which differentiate species, which in general do not Mendelize but result in a blended inheritance.

A certain number of cases are on record in which Mendelian inheritance has been observed to occur in species crosses. One such case was studied in my laboratory and reported by Detlefsen. A species of cavy from Brazil was crossed with the guinea pig. The type of agouti pattern of the coat is slightly different in the two species, the guinea pig having a light belly, the Brazilian cavy a dark belly. That there is a specific difference between the forms crossed is evidenced by the complete sterility of the F_1 male hybrids, though the females were fertile. Light belly was dominant in the hybrids but segregated in typical Mendelian fashion in the next generation. Mutation in the agouti gene had occurred, in one of the species crossed, from the supposed common ancestral type. This mutation behaved in a species out-cross exactly as it would in a cross within the species, as a Mendelian alternative. But the great majority of species differentials are not of this sort, are not due to single gene mutations, and do not give a Mendelian but a blended inheritance. For their evolution the theory of gene mutation is an insufficient explanation.

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OBSERVATIONS ON THE CARNIVOROUS HABITS OF THE SPEAR-NOSED BAT, PHYLLOSTOMUS HASTATUS PANAMENSIS ALLEN, IN PANAMA

By Lawrence H. Dunn

Little is definitely known concerning the feeding habits of many of the bats of Central and South America and it is believed that the following observations on the carnivorous habits of the spear-nosed bat, *Phyllostomus hastatus panamensis* Allen, in Panama, may be of interest.

It is evident that the food habits of this bat have been under question for a number of years. Elliot (1), writing of the genus "*Phyllostoma*," mentions the possibility of these bats being of carnivorous habits, as follows: "Like some of the large insectivorous bats, the species of this genus may possibly feed on smaller bats, which fact may have given them the reputation, long borne by *P. hastatum*, of being sanguineous."

My first observation that indicated this bat was a killer and flesh eater occurred on April 27, 1929. On the day previous to this date I visited the Chilibrillo Caves, located about fifteen miles from Panama City, and captured 34 bats. Seven of these were *Phyllostomus hastatus panamensis* and 27 were the smaller bats, *Hemiderma perspicillatum aztecum*. Since the only route by which these caves could be reached at that time was a rather difficult one to travel, only one cage in which to place the bats was carried. This was a light, wooden box large enough to hold two five-gallon tins of kerosene, for which purpose it had formerly been used. The wood on one side had been removed and replaced by small-meshed wire netting. Owing to a late return to the laboratory the bats were left all together in the cage for the night. The following morning there were but eight bats left alive. This number included the seven *Phyllostomus* and one of the *Hemiderma*, the latter being so badly injured that it died a few hours later. The other 26 *Hemiderma* evidently had been killed during the night by the seven larger bats. The wings, feet, legs and shreds of flesh were all that remained of five of the dead *Hemiderma*. Four others were mangled and partly eaten. The remaining 17 were somewhat crushed and torn but were not badly mangled.

Subsequently, while engaged in studies in connection with the susceptibility of bats to various human and animal diseases, I had occasion to keep a number of *Phyllostomus* in captivity for periods varying from a few days to three months and more. They were caged in the laboratory animal house and readily responded to captivity. Not much attention was paid to their diet other than to give them plenty of fruit of various kinds and an occasional piece of meat. It was noted that the latter was always quickly eaten.

On July 4, 1932, an adult female *Phyllostomus h. panamensis*, weighing 104 grams, that had been captured in a stable in the Canal Zone, was received at this laboratory. It was decided to make use of this specimen in conducting some observations on the food habits of the species and she was, therefore, placed in a wood and screen cage, 20 x 20 x 20 inches, and kept in my office where she could be closely observed. Ripe banana was placed in the cage daily but during the first few days the amount eaten was comparatively small for a bat of this size.

On the evening of July 9 a small dish containing 5 cc. of defibrinated blood was placed in the cage. The next morning the dish was empty. The following night the bat drank another 5 cc. of blood, ate a good sized piece of monkey liver and also some banana.

Five cockroaches, *Periplaneta americana*, each of which was more than an inch and a quarter in length, were placed in the cage on July 17th. A piece of the hard outer wing, or tegmina, of one of the roaches was all there was to be found the following morning. At 10 a.m. July 18, eight more of these roaches were put in the cage. About five minutes later a snapping and crunching sound was heard in the cage and the bat was found to be feeding on one of the roaches. She was hanging from the top of the cage by her feet and holding the roach to her mouth by means of her thumbs and ends of the forearms. The noise made by her chewing would lead one to suspect that she was deriving keen pleasure from her lunch on the roach. On the morning of July 19 all that remained of the eight roaches was a small part of the posterior end of one, four outer wings and a few small fragments. Ten large roaches were then put in the cage. During the night of July 19 seven of these were consumed, except for a few small pieces of the outer wings, two others were partly eaten and the tenth was still alive. This last roach was devoured during the following day.

On the evening of July 21 a live, adult mouse, *Mus musculus musculus*, of medium size was placed in the cage. The following morning it was found that the mouse had been killed and eaten, with the exception of the hind quarters and the tail. The skull and all the bones of the fore and middle part of the body had been consumed. During the following four consecutive days a live mouse was placed in the cage each day; these were killed and the head and anterior half of the body eaten by the bat each night. The hips, hind legs, tail and sometimes part of the entrails were not consumed.

Owing to the difficulty in securing live mice no more were obtained until August 19. During this period of twenty-five days the bat fed only on banana. Defibrinated blood was placed in the cage on several occasions but it was not taken.

At 10 a.m. on August 19 a large mouse was captured and placed in the cage. A few minutes later the sudden noise of a struggle was heard and on investigation it was found that the bat had caught the mouse and was holding it with her mouth and wings. Her teeth were gripped on its back just in front of the hips. The mouse was still struggling and squeaking and apparently was attempting to bite the bat on the thumbs and ends of forearms. It was evident from the vigorous exertions of the mouse that the bat was holding it only by the skin on its back and did not have a sufficient grip on its body to crush it. The bat was hanging from the ceiling of the cage by one foot, the other leg being

bent over with the foot resting on one of the wings. After several attempts at what seemed to be efforts to hold the head of the mouse with her thumbs and ends of forearms the bat put her head, with the mouse in her mouth, inside her wings, which were held partly extended in front of her to form a pocket, and after making several quick movements with her head and wings she straightened out to hang with her head downward again. She now had the back of the head of the mouse in her mouth. The mouse was motionless and apparently was dead. In putting her head between her wings the bat evidently had made use of the wings to aid in holding the mouse until she could shift her mouth hold to its head and crush the skull. The bat now began eating the mouse, beginning at the head, with a chewing, crunching sound. The wings of the bat were partly extended in front of the under surface of her body with the ends of the forearms held together and the second and third metacarpals of one wing held together and in close contact with those of the other wing. This formed the wings into a trough-like pocket which probably helped to support the carcass of the mouse while the bat was feeding on it. At the end of sixteen minutes the head, shoulders, and breast of the mouse had been consumed and the remainder dropped to the floor of the cage. Approximately six hours later the bat descended to the floor of the cage and after taking the remaining part of the carcass in her mouth climbed up, again to hang head downward and enjoy another meal. Only the tail and a few small pieces of entrails were left when she finished eating.

On the afternoon of August 20 a large adult mouse was put in the cage. This mouse was very active and although the bat evidently caught it with her teeth several times and squeezed it hard enough to bring forth a squeal of pain each time, she did not succeed in holding it. After eluding the bat for about fifteen minutes the mouse took refuge in one of the folds in the cloth sleeve that formed one side of the cage. The bat had been crawling rather clumsily about the cage in pursuit of the mouse and now proceeded very quietly to creep up the cloth of the sleeve and push her head down in the fold in which the mouse had hidden itself. The bat almost immediately withdrew her head but she now had the head of the mouse firmly gripped in her jaws. This mouse was partly eaten during the next eleven minutes and in the early evening the remainder was consumed. Only the tail was left after the second meal and during the night even that was devoured.

On each of the following days, August 21 and 22, a mouse was consumed. A small piece of entrails and the tail of one was left but even the tail of the other was eaten.

No more mice being available at this time it was decided to see if birds would be killed and accepted as an article of diet by the bat. On August 24 an adult bird, a honey creeper, *Cyanerpes cyaneus cyaneus* (Linnaeus), about four and a half inches in length, was placed in the cage. The bat immediately became markedly excited and made numerous attempts to catch the bird. The cage being too small to permit the bat to use her wings she could only crawl about on the screen of the cage with her feet and thumbs and the bird had little difficulty in evading her. Twice the bat dropped from the side wall of the cage in unsuccessful attempts to alight on the bird. After repeated fruitless attempts to capture the bird the bat ceased her efforts and during the rest of the day remained quietly hanging from the top of the cage whence she continued to watch the movements of the bird. Her efforts during the night evidently were more successful and the following morning all that remained of the bird were 46 of its larger feathers, from wings and tail, and ten smaller ones. The beak, claws, and even all other feathers had been consumed. On the following day a second bird of the same species and size as the first one was placed in the cage at 9:30 a.m. The bat captured this bird about 4:40 p.m. and began feeding on it. All that seemed to escape its jaws were the feathers that dropped while the bird was being eaten. At the end of twenty minutes a number of feathers, the beak and the fleshy terminal end of the body bearing the tail feathers were all that remained of the bird. During the night the flesh on the piece of rump was also eaten. The next morning 28 of the larger feathers and 17 small ones and the beak were all that was left of the bird.

A mouse placed in the cage on August 31 was completely consumed, not even a piece of the tail being left.

Wishing next to determine if the *Phyllostomus* would kill and devour smaller bats an adult female long-tongued bat, *Glossophaga soricina leachii*, was put in the cage on September 4. The *Phyllostomus* did not appear to show much interest in the smaller bat and the latter did not exhibit any marked evidence of fear of the larger one. The smaller bat selected a site at the top of the cage from which to hang scarcely more than six inches distant from the *Phyllostomus*. The wings and the joined legs represented all that remained of the *Glossophaga* the following morning. The smaller bat had been killed and its head and body, including the skull, ribs, and vertebrae, had been eaten. During the night of September 5 a second bat of the same species also was killed and the head and part of the body eaten.

An adult short-tailed bat, *Hemiderma perspicillatum aztecum*, placed in

cage on September 8, was killed during the night and the greater part of it eaten. The wings, legs, and a small mass of skin and flesh were left, but all bones of the head and trunk were consumed. A second bat of this species that was placed in the cage on September 9 was not killed until the night of September 11. The head and most of the body were then consumed.

Another *Glossophaga soricina leachii* was placed in the cage at 4 p.m. September 15. Two hours later all that remained of this bat were the wings, and during the night the greater part of these also was eaten. The pieces left consisted of the ends of the forearms, with a few small pieces of bones of the fingers, and shreds of wing membrane attached. One thumb also was left at the end of one of the forearms. It was rather surprising to note that the long bones of the forearms, the claws of the feet, and one thumb with its nail attached had been consumed.

An adult house wren, *Troglodytes musculus inquietus* (Baird), more than four inches in length, was offered the bat at 4 p.m. September 1. The bird flew about in the cage for nearly a minute before it appeared to notice the bat. It then alighted on the floor of the cage at the side opposite from that on which the bat was hanging, where it remained very quietly with its gaze directed toward the bat. Its behavior would lead one to suspect that it recognized danger from the bat and showed fear. At the end of five minutes a slight tapping of my fingers on the side of the cage near the bird caused the latter to take flight again. After darting about the cage for a few seconds it struck the screen below where the bat was hanging. The latter with unexpected rapidity seemed to straighten her legs and to stretch down and grasp the bird by the side of its breast with her mouth. As the bird struggled the bat quickly turned her head to one side to hold the bird with her right wing while she shifted the grip of her jaws until she grasped the neck of the bird. The wren was killed immediately. The bat then began a steady chewing which was accompanied by the usual snapping and crunching sounds. This was continued for 21 minutes. The bat ate the bird from the neck downward toward its tail. Nothing fell to the floor of the cage except some feathers until the chewing ceased and the appetite of the bat apparently was satisfied for the time. Four pieces of the bird were then dropped. These consisted of (1) foot, leg, and piece of thigh, (2) foot and part of lower leg, (3) head with beak intact, and (4) part of a wing with feathers attached. No blood nor any liquid was in evidence. These pieces were left in the cage and the following morning only 26 large feathers from the tail and wings and 14 small ones from other parts of the

bird were present. The rest of the pieces, including the beak and both feet, had been eaten during the night.

At 10 a.m. October 1 an adult female bat, *Uroderma bilobatum*, was placed in the cage. In four minutes the *Phyllostomus* caught the smaller bat and was holding it in her mouth. The *Uroderma* was voicing shrill squeaks and struggling vigorously and after about twenty seconds it apparently bit the larger bat, since the latter gave a sharp squeak of either pain or anger and dropped the *Uroderma* to the floor of the cage where it landed with wings outstretched and remained motionless. The *Phyllostomus* immediately ran down the side of the cage and when close to the small bat paused to watch it for a few seconds and then extended a forearm to touch the small bat with her thumb. After repeating this movement several times she took the *Uroderma* in her mouth and ascended to hang from the ceiling of the cage while she devoured it. This stealthy investigation on the part of the bat to ascertain if the *Uroderma* was dead was extremely interesting and might be likened to the actions of a big game hunter in examining his kill to make certain it is dead or whether another shot need be given before relaxing his caution or laying aside his gun. The head and shoulders of the *Uroderma* were eaten at this time. At 4:15 p.m. the *Phyllostomus* began her second meal of the day and fed on the carcass for 19 minutes. The wings of the small bat were all that remained after the second meal.

A large, adult male little bull dog bat, *Dirias albiventer minor*, was next tried out. This was a robust bat with a forearm length of more than 60 mm., and it was considered probable that the *Phyllostomus* would not attack it. The *Phyllostomus* appeared to show a considerable amount of interest in the other bat as soon as the latter was placed in the cage. The *Dirias* has the most offensive odor of any species of bat that I have handled in Panama. The males especially emit an extremely strong scent of musk. It would appear that this odor had a strong attraction for the *Phyllostomus*, whether from a sex standpoint or for some other reason it was not possible to decide. She moved to where the *Dirias* was hanging and seemed to smell him over very closely and at times appeared to be rubbing her snout about on his back. As it became dusk, the evening of the same day, the *Phyllostomus* again moved near the other bat and after smelling him over for a few seconds opened her mouth and slowly advanced to bite him. As her mouth was about to close on the neck of the *Dirias* the latter moved to another location in the cage. This was repeated a number of times while I was watching but each time the large bat seemed to be very slow about gripping the other.

The following morning the *Dirias* was found to be dead and the greater part of its head and the abdomen and entrails had been eaten. The lower jaw and the upper tooth row on either side had been cleaned of all flesh but apparently the teeth were not suitable for food and had been discarded. None of the thorax or abdomen was eaten and it is suspected that this was due to a small amount of soft, oily, wax-like substance having a very objectionable odor that was present just beneath the axillae of the *Dirias*.

Late in the afternoon of October 2 a male Coiba Island mastiff bat, *Molossus coibensis*, was placed in the cage. At dusk the *Phyllostomus* was heard chewing and she was found to be feeding on the bat. Only one wing and a small piece of flesh remained of the *Molossus* the following morning. Two days later another bat of this species was eaten until only a small piece of one wing was left.

Another large male *Dirias* was offered on October 9. With the coming of dusk the *Phyllostomus* began her attack on this bat. She adopted the same tactics as those used with the previous specimen of this species, following it about the cage and without any haste approaching it and snapping at it with her teeth. The bites seemed to hardly more than touch the skin at times but at each bite the smaller bat changed to a different position in the cage only to be followed by the larger one. With the exception of a few short periods when the large bat stopped to clean and comb herself this stalking was continued for at least an hour while I remained to watch it. Whether the repeated toilet performed by the *Phyllostomus* signified attempts to rid herself of the odor or taste of the other bat that she may have acquired while biting it I am unable to say, but it would seem as though this might be the case. The large bat seemed simply to be wearing out the other by chasing it about and possibly trying to disable it with a single snap of her teeth without attempting to hold it. She may have been afraid to try to hold the smaller bat or else may have disliked the smell of the other so much that she did not want to hold it too close to her. During the night the smaller bat was killed and like the previous one of this species only the head, abdominal region, and genitalia were consumed. The breast and back were not eaten. Two small pieces of the lower tooth row with no flesh attached were found to have been discarded as before. During the next seven days the bat killed three more *Dirias a. minor*, these being females, and ate about the same parts and amount of each one as of the previous two. Most of the teeth were discarded on each occasion.

A mouse was killed and eaten by the bat on October 25 and another on October 27.

It was noted that a mouse, bird or bat was seldom entirely consumed by the *Phyllostomus* unless she was very hungry for flesh. Usually she fed a second time on her kill about six or seven hours after the first meal. This would lead one to believe that under natural conditions she would feed twice and possibly three times each night. In considering this my curiosity became aroused over the question of whether under natural conditions the *Phyllostomus* makes one or two kills during the night. The actions of the bat in captivity indicated a fear or dislike at being on the floor of the cage; she devoured each kill only while hanging head downward suspended by her feet and with her prey grasped in her jaws. If this occurs under natural conditions, as seems probable, the part of the animal or bird not consumed at the evening meal would be dropped to the ground beneath where the bat happens to be hanging. It may be surmised that the bat would prefer a fresh kill for each meal, if obtainable, rather than to feed on the part of the carcass that may have been lying on the ground six or seven hours, if not already destroyed by ants or rodents. Should the bat make a fresh kill each meal it would mean two or more small birds or mammals killed each night while if the bat be more or less of a scavenger in feeding more than once on the same animal only one kill would be made nightly.

In an attempt to gain some information on this question two adult mice were given to the bat at 4:45 p.m. November 1. She captured and killed one of these mice in less than two minutes and immediately began feeding on it. The second mouse in seeking a place of concealment several times jumped into the pocket formed by the wings of the bat. She promptly ejected it each time but without interrupting her feeding upon the first mouse. At the end of 13 minutes she had consumed the head and anterior half of the first mouse. She then dropped the rest of the carcass and captured the second mouse and began feeding on it. Sixteen minutes later the fore parts of the second mouse were eaten and the rest dropped. The next morning only the tails, hind legs, thighs, and entrails of the two mice remained.

Three mice were offered at 4:30 p.m. November 5. The bat killed one and began feeding on it within a few seconds. After eating the head of this first mouse she dropped the remainder and killed a second one and began feeding on it. The tail of one mouse and the tail and hind quarters of each of the other two remained the following morning.

Two mice that were given the bat on November 9 were killed and nearly all consumed.

Between November 10 and December 19, the bat killed and ate seven more mice. Undoubtedly she would have devoured many more had they been given to her.

This *Phyllostomus* died on December 19, after 168 days in captivity.

During all the time this bat was in captivity a supply of fresh, ripe banana was placed in her cage daily, and each night, with but one exception, some of the fruit was eaten. When there was flesh to feed on the bat usually took only a small amount of the banana. When there was no mouse, bird, or bat on which to make a meal more of the fruit was eaten. On the night the three mice were devoured the banana was not touched.

The completeness with which the bat devoured the bones of her victims spoke well for the crushing force of her teeth and jaws and also for the disintegrating properties of her digestive juices. In order to observe how thoroughly the bones were digested all fecal pellets excreted by the bat throughout the period extending from October 1 to October 19 were removed from the cage each day and saved. At the end of the nineteen days these pellets were lightly macerated in water until dissolution occurred. This suspension was then passed through a sieve made of metal gauze having eighteen meshes to the inch. A comparatively small amount of hair was the only substance that did not pass through the sieve. No pieces of bone were found despite the fact that the *Phyllostomus* had eaten eight bats during the period that the fecal pellets were being collected.

If we may judge the *Phyllostomus* by its behavior in captivity, we must conclude that this bat seeks a flesh diet under natural conditions. If so it may destroy many small birds that are active at night and may even seek out those of diurnal habits at their roosting places and nests. It may also devour many mice and other small rodents of nocturnal habits. The seeking of prey of this kind may account for specimens of this species of bat being occasionally captured in barns and stables.

So far as I have been able to learn from the limited amount of literature dealing with the Chiroptera that is available to me at this time the only other bat known to be of carnivorous habits is the *Megaderma lyra* Geoffroy of India. This species also appears to feed on birds, bats, mice, and other small vertebrates. Some very interesting information concerning this bat in Ceylon has been given by Green (2) who states: "In a previous number of this Journal I have called attention to the carnivorous habits of bats of the genus *Megaderma*. I have found frequent signs of its depredations in the remains of birds and small bats dropped

in my verandah. I have since seen the fragments of a mouse (consisting of the feet and part of the head, mingled with the characteristic excreta of a bat) that had evidently been captured and devoured by the same animal. But, until quite recently, I have never come to close quarters with the bat itself. Examination of a loft above the Royal Botanic Gardens Laboratory has, however, revealed a stronghold of *Megaderma lyra*. * * * * The destruction of small birds, due to these vampire bats, must be enormous. Day after day, for weeks together, I have found my verandah strewn with the wings and feathers of small birds, principally of the dainty little honey-sucker (*Cinnyris zelonicus*)." Gleadow (3) informs us: "Referring to Mr. Ernest Green's query on p. 835, vol. 17 of this Journal, there is no doubt whatever that *Megaderma lyra* habitually feeds on birds and mice. These verminiferous vermin (the bats) used to annoy me greatly by catching mice about my house, and fetching birds out of their comfortable nests in the night and chewing them up in the corners of rooms or verandahs. We are spared the use of our inductive and deductive faculties (which would perfectly suffice) by the simple fact that I have seen them do it many times. The well known zoologist, Mr. F. Finn, was living with me at the time. We caught and caged the bats and he fed them on small birds brought for sale by the natives." Primrose (4), in writing of this bat tells us: "For the past three years I have been puzzled to know whether my surmise that the Indian Vampire Bat (*Megaderma lyra*) was responsible for the remains of small birds, chiefly of the Indian Bush Chat (*Pratincola maura*), small bats and insects, which are always picked up from the floor of my front verandah every morning in the cold weather, and which is at times quite strewn with them. * * * * To-night, however, I have been able to confirm the fact that undoubtedly small birds do form a portion, and here a substantial one, of *M. lyra's* food, having just killed one in the act of eating a small bird, and the bat and its victim lie before me as I write."

Our present knowledge of carnivorous bats now appears to include two widely separated species, *Megaderma lyra* Geoffroy of the southern part of Asia and *Phyllostomus hastatus panamensis* Allen of tropical America.

SUMMARY

Observations on *Phyllostomus hastatus panamensis* in captivity demonstrate this bat to be of carnivorous habits. One specimen kept in captivity for 168 days killed and ate 25 mice, 13 bats and 3 birds.

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THE REPRODUCTIVE CYCLES OF SOME CAVE BATS

By Mary J. Guthrie

In the course of the collection of bats for a cytological study of the organs related to the reproductive capacity, a number of observations on the reproductive cycle have been made. These are presented here because of the interest aroused by many aspects of the sexual cycle of the bat and the scant information available.

The period of hibernation in many of the bats of the temperate zone occurs between an autumnal insemination and a vernal ovulation and gestation. Miller (1931) cited bats as examples of what he termed type I of mammalian sexual behavior in which the mating behavior in both sexes is limited to short, definitely determined periods that are usually seasonal. Heape (1900) used the bat as an illustration of the statement that ovulation may occur without the coincidence of estrus. Courrier (1927) reviewed the work of earlier students of the bat. Of these, Benecke (1879) and Eimer (1879) formulated the interpretation that coitus occurred only in the fall and that the sperm introduced at that time were responsible for the activation of the eggs that were ovulated in the spring. However, Robin and Vogt (1881) believed that copulation should occur again in the spring because the male ducts contained sperm at that season and young females were not inseminated in the fall. Duval (1895) observed coitus in three pairs of Rhinolophes in May, and Rollinat and Trouessart (1896) reported erection in male Serotines in February. After studying the period of spermatogenesis and the secondary sex characters of seven kinds of bats, Courrier concluded that coitus in the spring was exceptional, although he observed attempts at copulation during the winter and spring. Hartman and

Cuyler (1927), in an abstract, stated that most observations of sperm in the uterus of the bat during the winter could be explained on the assumption of repeated coitus. No evidence, other than the presence of sperm in the male ducts as well as in the uterus, was cited for such an interpretation.

The observations to be reported here bear upon the questions of the longevity of the sperm[1] and the period of sexual activity in the bat. In addition, data on the gross and some of the cellular changes in the ovaries and genital tract of the female make it possible to seriate the events of the reproductive cycle. A detailed study of fixed material from the individuals described here is in progress.

This work was supported in part by a Grant-in-Aid from the National Research Council for which acknowledgment is gratefully made. I am indebted to my colleague, Dr. F. H. Woods, as well as to Mrs. F. H. Woods and Dr. Katharine R. Jeffers, for aid in the collecting, and to Miss Virgene Warbritton for her painstaking technical assistance.

MATERIAL AND METHODS

During the period from April 1, 1931, to July 1, 1932, 581 female bats were studied before fixation, and over 50 others were studied without fixation. Three genera and six species are represented by the following numbers: 196 *Myotis lucifugus lucifugus*, 145 *Myotis sodalis*, 148 *Myotis grisescens*, 2 *Myotis keenii septentrionalis*, 73 *Pipistrellus subflavus subflavus*, and 17 *Eptesicus fuscus fuscus*. Careful descriptions of the species of *Myotis* can be found in the monograph by Miller and Allen (1928). The identifications of species were checked by Mr. G. S. Miller, Jr., of the Division of Mammals, Smithsonian Institution, United States National Museum, and by Mr. C. C. Sanborn of the Division of Mammals, Field Museum of Natural History. A loan of skins and skulls from the Field Museum was extremely useful before I became familiar with the species.

The animals were collected at fortnightly intervals from two limestone caves in the vicinity of Columbia, Boone County, Missouri. These caves are locally known as the Rocheport Cave and Hunter's Cave. They have been described by Guthrie (1933); records of the seasonal movements of the bats and the collection notes have been presented in the same paper.

At the time of each collection, some bats were killed upon arrival at the laboratory. Others were kept for varying lengths of time, sometimes at hibernating temperatures, before killing. The cages were placed in pans of water in order to furnish sufficient moisture, which was as important as moderate temperatures in keeping the animals alive. They ate many things including liver, brains, powdered milk and graham flour paste, carrots, spinach, and bananas; but no combination that would sustain activity was found in the limited series tried.

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[1] A paper by Carl G. Hartman (Quart. Rev. Biol., vol. 8, pp. 185–193), which appeared while this paper was in press, contains an extensive review of the literature on this subject.

After the bats were killed by decapitation, the degree of wear of the teeth was observed with a hand lens, and the amount of subcutaneous fat was recorded. The ovaries and complete tract were removed together and placed in a depression slide in Locke's solution. The amount of fat surrounding the ovaries and tubes was noted before it was removed under a binocular. Next, the ovaries were freed from the tubes; the size and shape of the ovaries, and the number and the degree of development of the follicles were observed. The tubes were checked for the visibility of the lumen, which depended on the presence of contents, for the differentiation of the mucosa, for diameter, for segmentation movements, and for movement as a whole. In some cases, one tube was sacrificed for microscopic examination of the contents of its proximal and distal halves. If ovulation had occurred, the tubes were searched, through their walls, for the eggs in order to determine the stage of development. The entire tract contracted rhythmically at some periods, and each specimen was observed for that, as well as for the size relations of the uterine horns to one another and of the vagina to the uterine body. Some of the contents of the vagina was removed with a pipette and examined with the microscope. Uterine contents were obtained by cutting off one horn and gently pressing in a drop of Locke's solution.

In February it was decided to try to obtain vaginal contents from the living animals. Toothpicks were shaved to make delicate spatulas. The bat was held securely stretched in one hand, and great care was exercised in order not to rupture the thin vaginal wall. Although a number of vaginæ were injured, it was possible, in some cases, to take contents for eleven consecutive days before killing. Material withdrawn from the vagina was examined in a drop of Locke's solution. This was done so that insemination might be detected, if possible, and to find if there was any change in the types of cells present from day to day.

OBSERVATIONS

Occurrence of sperm in the males: The occasional records of examination of males for spermatozoa are presented in Table 1. The age of specimens was determined by the wear on the teeth, particularly the canines and premolars. Any wear visible with a hand lens classes the animal as "old." The lack of complete data in some cases is due to the fact that their use in this manner was not anticipated. However, it is clear that the occurrence of sperm in the ducts of the male is not confined to the autumn. The observations were made on teased, fresh material.

Erection, upon handling, was observed on February 28, 1932, and throughout the spring in *M. lucifugus*. On May 5, 1932, an old *M. grisescens* exhibited the same phenomenon, while young males did not. Two similar instances were noted in *Eptesicus* on February 20 and 28, 1932. In *Pipistrellus*, erection occurred in some specimens during March and April but was not so conspicuous as in the other forms. Copulation was not observed in any species at any season. In a few cases, a female and male of *M. lucifugus* were taken together, separated from the larger groups. Although two females or two males were found together just as frequently, other data make these pairs seem significant. Hahn (1908) has reported the observation of copulation in a few pairs of *M. lucifugus* toward the last of October in Indiana, and in *P. subflavus* at the end of November.

General observations on the reproductive tract of the female bat: Nothing has been

more impressive in the study of these hundreds of bats than the individuality of each specimen. In spite of the recognition of the variation that exists, it is

TABLE 1

Presence of spermatozoa in male bats

SPECIES	DATE	NO. AND AGE	TESTES	DUCTS
Myotis lucifugus	1/23/32	1	Not observed	+
	2/28/32	Several old and young	+	+
	5/ 1/32	1 young	+ (Some immature)	+
	5/17/32	1 old	+ (Very few)	+
Myotis sodalis	10/ 9/31	1	+	+
	12/ 3/31	1 young	+	+
	1/ 8/32	1	Not observed	+
	1/16/32	1	Not observed	+
Myotis grisescens	7/28/31	6	−	−
	9/ 4/31	3	Not observed	+
	10/ 9/31	6 young	+	+
	11/21/31	1	+	+
	5/ 5/32	1 old	−	+
	5/ 5/32	2 young	−	−
	5/17/32	1 young	−	−
	6/24/32	5 old	−	−
Pipistrellus subflavus	1/17/32	1	Not observed	+
	5/ 5/32	1	−	+
	5/ 5/32	1 old	−	+
	5/17/32	1 old	+	−
	5/17/32	1 old	−	+
	5/17/32	1 young	+ (Very few)	+
	5/17/32	1 young	+ (Very few)	+ (Very few)
	5/17/32	1 young	−	−
	5/19/32	1 young	−	+
	5/30/32	1 old	−	+
Eptesicus fuscus	11/21/31	1	+	+
	2/28/32	1 young	Not observed	+
	5/24/32	1 old	−	−
	6/19/32	1 old	−	−

believed that when all the factors noted in the different females are considered generalizations can be made.

For one not experienced in the classification of bats, the identification of *M. lucifugus* and *M. sodalis* was difficult when both were not present for comparison of the usual diagnostic features. It was, therefore, a pleasant surprise to find that the round ligaments of the uterus are pigmented in *M. sodalis* and not pigmented in *M. lucifugus*. Further, the size and shape of the ovary differs in the two species: that of *M. sodalis* is larger (1 x 2 x 1 mm.) and lobed, while that of *M. lucifugus* is smaller and rounded (1.1 x 1.3 x 1 mm.) with a very inconspicuous neck. The round ligaments in *M. grisescens* are pigmented and the ovary best described as somewhat oval in shape (2 x 1.5 x 0.8 mm.). In the two specimens of *M. keenii*, the size and shape of the ovaries resembled closely those of *M. lucifugus*. The ovaries of *Eptesicus* and *Pipistrellus* are rounded, without necks, and measure 1 x 1.5 x 1 mm. in the former and .75 x .75 x .25 mm. in the latter. These are individual measurements, not averages.

The species of *Myotis* described here mature only one ovum; and only one follicle increases greatly in size, although many begin to grow. A single exception to this statement must be made in the case of one *M. sodalis* in which a four-cell stage was found in the right tube and an oöcyte in the ostium of the left tube. In *M. sodalis* the follicles ripen with equal frequency in the two ovaries without respect to age. However, there is a distinct preponderance of follicles ripening in the left ovaries of the first season females of *M. lucifugus*. No interpretation can be suggested for this observation. The embryo always develops in the right uterine horn, which is, therefore, larger than the left horn in sexually mature individuals.

In *Pipistrellus* and *Eptesicus*, as many as seven follicles conspicuously larger than the others were found in the two ovaries. Out of 70 *Pipistrellus* females, 24 had 4 large follicles or tubal eggs; 17 had 5; 15 had 3; 9 had 6; 2 had 7; and 1 each had 2, 1, and no large follicles or tubal eggs. Apparently all of the follicles that grow conspicuously are capable of ovulation since both counts of 7 were made on tubal eggs. No data are available on the development of these eggs, and some may not complete gestation. Hahn (1908) recorded the collection of only one pregnant *P. subflavus* female in a cave; on June 6, this individual had three 2 mm. embryos. Bailey (1931) reported two as the usual number of offspring in *P. hesperus hesperus*, and Krumbiegel (1930) listed one to two embryos as typical for *P. pipistrellus*. The number of specimens of *Eptesicus* is too small to do more than establish a possible range of large follicles. Only two cases of ovulation have been observed in this species. On March 4, 1933, a female that had been in the laboratory for eight days had 6 tubal eggs, and on March 10, 1933, a female that had been collected for two weeks had at least 4 tubal eggs. The number of young for this species is given as one by Bailey (1931),[2] and for several European representatives of *Eptesicus* as one to two by Krumbiegel (1930). Both *Pipistrellus* and *Eptesicus* have uterine horns that are similar in size; those of the former varying from 2.5 to 3 mm. from the median notch to the lateral borders, while those of the latter range from 3 to 4 mm. In these two species, the eggs ripen with equal frequency in the two ovaries.

The tubes in all the species examined were very transparent, and internal

[2]On June 9, 1933, a female *Eptesicus fuscus* with two recently born young attached was brought to the laboratory.

conditions could be determined by means of a binocular. Variations in the height of the mucosa were observed as early as June 19, 1932, in *M. grisescens*. At times, the tube was found to be undergoing a movement described as segmentation. This kind of movement would produce a very complete churning of any contents of the tube and was quite distinct from a movement of the tube as a whole, which probably would effect a peristalsis in an attached tube. Such tubal activity was, in turn, separable from the rhythmic contractions of the uterus which occurred at certain times. The lumen of the tube was frequently quite conspicuous because of its contents. A very complete cap for the ovary was formed by the ostium. The diameter of the tube was sometimes conspicuously greater in the ostial half. No observations were made on the cervix of the uterus except to note that it was practically obliterated during pregnancy in *M. grisescens* by the expansion of the right horn. The cervical-vaginal canal varied considerably in size with the degree of contraction of the papilla through which it runs. In the species of *Myotis*, the vagina showed a wide range of sizes from a width comparable to that of the cervix to over twice that width. In *Pipistrellus* and *Eptesicus*, however, the vagina was never more than slightly larger than the cervix.

SPECIAL OBSERVATIONS ON THE REPRODUCTIVE TRACT OF THE FEMALE

Myotis grisescens

M. grisescens returns to the caves in June, coincidently with the time of parturition. On June 28, 1930, a few females with naked young attached were collected. No bats were found in the Rocheport Cave on June 10, 1931, but females and young were very numerous on June 20, 1931. Bats were reported to have been present in the Rocheport Cave on June 12, 1932, and were found in great numbers on June 19. All were females and young of *M. grisescens*. Out of twenty-eight specimens, three individuals were pregnant, and one of these gave birth to a young bat about six hours after collection. Three were taken with young that still had umbilical cords attached; the size of these young was no greater than that of the new-born. A considerable variation in the time of parturition in this species is indicated by the fact that on June 21, 1931, young bats collected and measured from the tips of their heads to the bases of their tails, ranged from 27 mm. to 40 mm. The largest was somewhat hairy and had the incisors, canines, and premolars erupted in the upper jaw. The twenty nine young taken on June 19, 1932, were extended on their backs after etherization and measured from the tips of their heads to the tips of their tails. The range for females was from 46 mm. to 65 mm., for males from 49 mm., to 69 mm. Comparable lengths for the young males *in utero* were 48 mm. and 49 mm. and for the new-born male 50 mm. After preservation in formalin, the forearms ranged in length from 13 mm. in the smaller uterine specimen to 26 mm. in the largest young. Miller and Allen (1928) state that the forearm in the adult is usually more than 40 mm. in length.

In the collection of June 19, 1932, the degree of uterine contraction as well as the length of the pubic ligament varied considerably. Vascularity of the uterus was reduced along with its skrinkage in size and the thinning of the *decidua basalis*. The uterus and vagina contained much blood and many large leucocytes which had ingested numerous degenerating erythrocytes. Small follicles were visible

at the surface of the ovaries in the lactating specimens; no external signs of *corpora lutea* could be seen in the pregnant females, although the ovaries appeared very large. Some of the tubes were enlarged in the ostial portion; most of them showed movement as a whole when stimulated; and in a few, segmentation was occurring. The lumen was not obvious in any case, but the mucosa was heightened, particularly in the enlarged portions. Some droplets of secretion and a few small leucocytes made up the contents of the tubes examined.

The most amazing observations were those of a well preserved oöcyte in the tube of one specimen and a degenerating oöcyte in the uterine horn of another. The tubal egg had a conspicuous zona to which two patches of cumulus cells were attached. The total diameter, measured under very slight pressure, was 0.116 mm.; the diameter of the oöcyte was 0.098 mm.; and the diameter of the germinal vesicle 0.030 mm. There was no perivitelline space. The degenerating oöcyte had an ill-defined zona, through which a pseudopodium of a leucocyte extended, and appeared to be fragmented. In two other specimens, what seemed to be rupture points were observed on the surfaces of the ovaries, but no oöcytes were found. The enlargement and movement of the tubes and ovulation immediately following parturition are of the utmost interest and will be further studied when material is again available.

The females collected on June 19, 24, and 25, 1932, had definite and usually conspicuous wear on their teeth, with five exceptions. These individuals had only a trace of wear or no wear on their teeth and had small uterine horns; they had not been pregnant. The immature females had some subcutaneous fat, and all specimens had some fat in the mesenteries of the tubes and ovaries.

By the end of July, most of the females had reduced mammary glands and uterine horns that were practically contracted after the expansion of pregnancy. Among these animals, some young females of the previous season and which had not been pregnant exhibited small follicles in the ovaries, heightened tubal mucosa, and segmentation during July. This was true, also, of a few bats that were still lactating toward the end of July, and of all except the present season's young during August and early September. The fat deposited around the ovaries, along the tubes, and subcutaneously, increased conspicuously during August and September.

M. griescens does not winter in the caves from which collections were made, and very few were obtained after the first of October. Unfortunately, specimens collected on September 22, 1931, were not examined for sperm. However, of four specimens collected on September 22, 1932, and examined without fixation, two had sperm in the uteri and two had none. In each case, one female had some wear on her teeth, the other's teeth were unworn. Enlargement of the tubes in one specimen collected on September 22, 1931, and examined three days later, is indicative of the receptive state if one can judge from observations on other species in the spring. Six specimens taken on October 11 and 19, 1931, were undoubtedly stragglers. Three of them had no sperm in the uteri, and three had very few. Leucocytes were present in all cases. On October 19, one specimen had light tubes and only a few sperm in the uterus. However, two old bats collected on November 11 and December 3 had many active sperm in their uteri, and the tubes appeared dark. One bat from the October 11 catch, probably a 1931 young judging from the undeveloped uterus, had no sperm. Inactive sperm were found in

the vagina of only one individual, but it should be noted that these specimens were killed on the day of collection. Not all of these bats had follicles that could be distinguished as vesicular. Until the cytological studies have been made the conclusion that vesiculation of follicles is positively correlated with enlargement of the right horn of the uterus must be considered tentative. It is entirely clear, from teasing of ovaries in the autumn of 1932, that vesicular follicles are not present in many bats that have been inseminated. The data would indicate that in all old specimens and many young ones copulation occurs in the fall before hibernation and that sperm remain alive in the uterus during hibernation.

M. griscscens differs from the other species studied in the time of sexual maturity, because many specimens that had little or no follicular growth and very few sperm were obtained during April. One such individual, interpreted as a migrant because of reduced fat, was taken at Hunter's Cave on April 2, 1931. By a rare good fortune, several hundred migrating *M. griscscens* were found in Hunter's Cave, where they apparently spent the day, on April 30. On May 1, fewer numbers were taken at the Rocheport Cave. Of these, the great majority were immature; they had only small follicles in their ovaries and few sperm, most of which were inactive, in the uterine horns. It seems improbable that these bats with most of their stored food exhausted could mature a follicle for the present season. In this connection, it may be recalled that some females of *M. griscscens* taken during the summer have obviously not been pregnant.

A few old females were among the migrants captured in April; one contained a vesicular follicle, and the others had ovulated. If these specimens are our summer residents, as seems somewhat doubtful in view of their entrance into the cave, the limits of the gestation period would appear to extend from May 1 to July 1.

The vaginal contents of twenty females caged with eleven males from the collections of April 30 and May 1 were taken for examination for four consecutive days after collection. No active sperm were seen and very few inactive sperm, although in some individuals inactive sperm were observed each day. Masses of inactive sperm and squamous or cornified cells were very infrequent in this species, but the other contents were like those of the several other species of *Myotis* studied.

Myotis lucifugus lucifugus

M. lucifugus was first obtained at the Rocheport Cave on October 19, 1931, when three young females were taken; a single young female was collected on September 22, 1932. These were very fat; each had one follicle larger than the others; sperm were present in the uterus; and the lumina of the tubes were filled. In one of these the right horn was not larger than the left. A single young female collected on October 28 had only small follicles but had abundant sperm. From the middle of November until the middle of April, this species was common in the caves in a hibernating condition.

With a few exceptions, the ovaries contained single follicles larger than the others when the bats entered the caves. After the first of December, most of these largest follicles were recorded as vesicular. Obviously, the young females of *M. lucifugus* reach maturity in the first summer. The first ovulations were recorded on February 17 in specimens collected on February 6 and kept in a warm

room. Thereafter, a few individuals ovulated under laboratory conditions; and by the middle of March, the majority of bats kept at low temperatures ovulated or showed tubal enlargement after a day in a warm room. However, no bats killed immediately after collection on March 25 and April 2 had ovulated, although at the later date all had enlarged tubes. One can assume that ovulation occurs normally in this species very soon after the females leave the caves. Development through the four-cell stage occurs in the tubes. Hahn (1908) reported that he had not found pregnant females of this species within caves.

In one case, an individual with worn teeth was recorded as being without sperm when collected; another was young and not inseminated. Other cases in which no sperm were found in the uterus were ones in which ovulation had occurred. The data seem to indicate that insemination occurs before the bats enter the cave for hibernation or immediately thereafter. The number of sperm in the uterus varied in different individuals and in general was greatly decreased, although rarely exhausted, after long periods in the laboratory. Both active and inactive sperm occurred in the tract. The sperm were always isolated except when inactive ones were massed with squamous and cornified cells in the vagina. Active sperm also occurred in the vaginæ of recently collected individuals irrespective of the date; but they were infrequent after the animals had been caged for a time.

The data are not complete for the presence of sperm in the tubes because observations could not be made without destruction of material desired for cytological study. On December 13, active sperm were recorded from the tube of a female taken with a male apart from the group. In most cases, the lumen was noted as being dark, which indicated that it had contents. It was assumed that these contents were sperm until examinations beginning in February revealed the presence of more leucocytes than sperm in the tubes in most instances and the complete absence of sperm in many "dark" tubes. The leucocytes of the tube were usually small and were in active locomotion when observed under high magnification. A few larger leucocytes which were assumed to be of the same kind as the small ones and which always contained ingested sperm heads, judged by shape and refractivity, have been seen in the tubes.

Leucocytes were almost always present in the uterus. The small ones occurred alone; large ones were never found in the absence of small ones. Clumping was a conspicuous characteristic of the small leucocytes. These clumps were very compact, and the cells did not separate when placed on a slide or if a cover was added. Large leucocytes did not form clumps, nor were the small ones always clumped. As many as twelve sperm heads have been counted in a single large leucocyte in the uterus, where the large type was frequently very numerous. Small and, occasionally, large leucocytes were also found in the vagina where the small ones were sometimes clumped or associated with the inactive sperm and cornified cells in masses.

Epithelial cells have not been seen in the tubal contents. In the uterus, epithelial cells were found but not in large numbers or regularly. They were sometimes spindle-shaped rather than squamous. Large squamous epithelial cells, occurring singly or in sheets, were characteristic of the vaginal material in many bats, while cells of the smaller, less flattened type were rarer. Cornified cells, distinguished by the indistinct nuclear outline, also frequently occurred in

the vagina, either in sheets or as isolated cells. Such cells have not been identified in the uterine horns. Groups of epithelial cells in finger-like associations were found in material obtained after the uterus was cut. They were cut from the endometrium; such villi are probably an indication of uterine growth.

Finally, these gross observations yield information concerning cell function. In the tubes and uterus, a non-cellular content could be identified by a difference in viscosity as well as by the presence in it of refractive drops. This secretion, as it has been called, was seen in the uterine contents when they were scant; it is believed that this was a real coincidence, not the result of overlooking a less conspicuous constituent in the other cases.

On February 28, vaginal contents were taken from twenty females that had just been brought from the Rocheport Cave. Separation into three groups was made on the basis of absence of sperm, absence of active sperm but presence of inactive sperm, and presence of active sperm. Individuals were marked when active sperm were found in later examinations. These were continued for eight days during which time males were caged with the females. Of the seven which had neither active nor inactive sperm in the vagina when collected, one had active sperm on the following day and six had inactive sperm. On the next two days, three other members of this group had active sperm, but none were seen in later examinations. Of the nine containing inactive sperm in their vaginæ at the time of collection, two had active sperm on the second day and six had inactive. No active sperm were found after this time, and inactive sperm were found in only one specimen after the sixth day. Four specimens had active sperm in their vaginæ when brought in, but after the fourth day no sperm were found. Variations were noted in the other contents, but nothing resembling a cyclic phenomenon could be detected.

Consequently, several other groups were examined. Twenty-nine females that had been at low temperatures from the time of their collection on February 28 were placed with males in a warm room on March 9. Contents were obtained from their vaginæ for from six to eight days. Only six of this lot had active sperm in their vaginæ but most of them had inactive sperm and masses containing inactive sperm, as well as cornified cells and leucocytes, on a number of days. On March 25, eighteen females were caged with males of the same collection as soon as they were examined after arrival at the laboratory. This series was continued through eight days. Only seven had active sperm at any time, but one of these had active sperm for four successive days. None had inactive sperm after the fifth day. However, only six of the females on which observations of vaginal material were made were entirely without sperm in the uterine horns when they were killed, and these were in early stages of gestation. Variations in contents were observed, but no periodicity or correlation with cellular changes reported for the vaginal material in other forms could be made out. No differences between young and old bats were apparent.

Myotis sodalis

M. sodalis was first identified from the Rocheport Cave in the collection of October 9 when one young female with sperm in the uterus was taken. From October 19 until the end of February, they were abundant; and the last one was obtained on April 16. In no case were sperm absent from the uterus in freshly

collected specimens, although after five days in the laboratory one female had no sperm in her uterus. In other cases, the uterus was free of sperm, or practically so, after a period in the laboratory; but this was not always so, nor did it depend upon the presence of males. Here, as in *M. lucifugus*, the fall insemination occurs before or as the bats enter the caves.

Largest follicles were recognizable in the ovaries of the first specimens taken, and as early as October 19 some contained vesicular follicles. A few young specimens did not have conspicuous follicles during the early fall, but none taken after November 1 failed to show considerable growth in a single follicle. The females of this species attain sexual maturity in their first summer. Ovulation was first recorded on February 15 in a specimen collected on February 6 and kept in a warm room. Other ovulations occurred, but none in freshly collected specimens. One must conclude that ovulation normally takes place after the bats leave the cave, which is earlier for *M. sodalis* than for *M. lucifugus*. Two and four-cell stages have been found in the tubes.

There are no essential differences between the contents of the tract in this species and those described for *M. lucifugus*. However, the occurrence of active sperm in the vagina was much less common.

Pipistrellus subflavus subflavus

Females were present in the caves from November 11 until April 30. Many contained vesicular follicles when they hibernated, and all were heavily inseminated. One specimen contained no sperm after six days and may have been too young for copulation, although several others had very few sperm after a stay in the laboratory.

Ovulation first occurred on March 7 in one specimen brought in on February 28. No other individuals collected on that date ovulated. Of the ones collected during April, all ovulated after a few days. Development progresses through the four-cell stage in the tubes. Here again, one must assume that gestation does not normally begin while the bats are within the caves.

The leucocyte content of the tract in this species was very conspicuous. The ostia were sometimes packed with small leucocytes, and this has been observed after ovulation has occurred. These leucocytes ingested sperm while in the tubes and also in the uterus. Many active sperm were found in the vagina in *Pipistrellus* even after several days in captivity. Either sperm are not eliminated so rapidly from the uterus as in *Myotis*, or vaginal conditions are more favorable for their continued activity. Aside from these differences the observations on *Pipistrellus* are quite similar to those on the *Myotis*.

On February 28 when the first examinations of vaginal contents were started on *M. lucifugus*, twelve *Pipistrellus* females were treated in the same way for nine to eleven days. It was extremely difficult because of the smallness of the vagina to obtain contents. All had either active or inactive sperm at the first examination. Active sperm did not occur after the ninth day in any specimen, but inactive sperm were found on the eleventh day in two individuals. When these bats were killed, only one of them had complete absence of sperm in its uterus; and in that one, observation was not satisfactory because of the presence of blood. Variations in the other contents of the vagina are not understandable in terms of periodicity.

Myotis keenii septentrionalis and Eptesicus fuscus fuscus

The number of specimens of *M. keenii* and *Eptesicus* is not sufficient to permit of any generalizations. *M. keenii* was undoubtedly migrating when taken on February 6 since the fat was greatly reduced and no other specimens were found. The two females contained vesicular follicles, but the one examined had no sperm in its tract. This is not unexpected in view of the interpretations to be placed on the data in the other species.

Eptesicus is probably not a common inhabitant of caves during the hibernation period. Females were collected in the large entrance of the Rocheport Cave from November 11, 1931, until January 16, 1932. They were without exception inseminated and contained some follicles that were larger than the others. On February 24, 1933, seven females were obtained, and two of these ovulated after a period in the laboratory. Insofar as the data are complete, they indicate no peculiarities in the activities and contents of the tract in this species.

DISCUSSION

The seasonal movements of the bats of the limestone caves that have been visited make it impossible to obtain a complete yearly series of any species. However, the observations indicate that no essential differences in the reproductive cycles occur in the species reported. An account of the sequence of events will be presented from the data at hand, although it is recognized that they are limited at certain critical periods.

The statement that insemination of female bats occurs in the autumn has not been questioned and is confirmed for these forms. It seems clear that copulation takes place before or as the bats enter the caves, since with very few exceptions in relatively frequent collections all females contained sperm in their uterine horns. Interestingly enough, insemination does not depend on the presence of large or even intermediate follicles. In the young females of *M. grisescens* in which only minute follicles were found in teased ovaries, there were some sperm in the uterine cavities. In *M. lucifugus*, *M. sodalis*, and *Eptesicus*, copulation had occurred in specimens in which no conspicuous growth of follicles had taken place.

That insemination occurs again in the spring at the time of ovulation is undeniable in *M. lucifugus* and *Pipistrellus*. The data on *M. sodalis* are insufficient but lend themselves to the same interpretation. In the observations on the tubal contents of *M. lucifugus* and *M. sodalis*, it was noted that small type leucocytes were always present when active sperm were found; and that in *Pipistrellus* leucocytes were sometimes massed in the ostia when no sperm were present, as well as when ovulation and insemination had occurred. The tubes at this time are greatly

enlarged; the ampulla may be two and a half times the diameter of the isthmus. This was found to be true in *M. lucifugus* in the spring when ovulation occurred after a period in the laboratory (as in many specimens from February on) and in specimens collected on April 2, 1932.

With these observations in mind, the course of events in the autumn and winter can be outlined. Three specimens of *M. lucifugus*, one of *M. grisescens*, and one of *Pipistrellus* are recorded as having enlarged tubes in the autumn. It may be assumed that these are individuals in which the period of autumnal insemination has been recent. During this period, numerous leucocytes have migrated into the tubal lumina; and the female bat hibernates with her tract filled with sperm and leucocytes. The conspicuous darkness of the tubal lumina, and of the uterine cavities in younger specimens in which the walls are thin, is to be explained on this basis. Furthermore, wherever the records are complete, leucocytes are found to make up most of the uterine contents. In collections of *M. lucifugus* up to the end of March, practically no large leucocytes are seen in specimens examined immediately after arrival at the laboratory; the same is true of *M. sodalis*. The small leucocytes are frequently clumped as noted in the ostia in *Pipistrellus* and in the uterine horns of many specimens. On the other hand, aggregated sperm were not seen; the sperm swam freely from the uterine horn as soon as it was cut while observed under the binocular. This is of interest since Yochem (1929) assumed that aggregation during hibernation might be responsible for the longevity of sperm in the tract of the female bat, and Redenz (1929) stated that the sperm were inactive in the uterine horns from the time of the fall insemination until the follicle ruptured in the spring. In cases where the data are complete, inactive sperm are always found together with the active ones in the recently collected bats; and where inactive sperm are recorded, various stages in degeneration have also been observed.

When the bats are brought into the laboratory and placed in a warm room, activities which rid the tract of its contents begin. The same is true if the animals are kept cold for some time in the laboratory before being warmed. Muscular activities result in the expulsion of uterine contents into the vagina and to the outside.[3] In several cases in *Pipistrellus*, dried masses found on the hair around the external genital orifice, when soaked and teased, have been found to contain recognizable sperm, leucocytes, and squamous cells. In one *M. lucifugus*, collected on February 24, 1933, a drop of milky urine observed upon our

[3] Benecke (1879) made similar observations on two species of European bats.

arrival at the laboratory was found to contain numerous inactive sperm, one active sperm, some leucocytes, and many cornified cells. The daily examination of vaginal contents gives indication of this passage of material until the uterus has its contents greatly reduced. Tubal and uterine contractions occur during this period and become increasingly noticeable as the end of the hibernating season approaches. It is anticipated that the cytological studies will yield an explanation of these observations. Bats collected in April showed that such elimination of tubal and uterine contents is normal for that season. Another activity which results in the reduction of sperm in the tubes and uterus is the phagocytic behavior of the leucocytes. These cells ingest sperm heads in increasing numbers so that many large leucocytes containing sperm heads are recorded after specimens have been in the laboratory for several days. Indications are that the persistence of sperm in the tract depends on the temperatures at which the bats are kept and their resultant activity. In *M. sodalis*, active sperm were present after the animals had been in the laboratory, at ordinary room temperatures, from October 28, until November 5 and 6 and from November 8 until November 14; but sperm were not present when the bats were kept from October 19 until November 14 and were almost exhausted when the time was from November 8 until December 6. When the animals were caged in an animal room at approximately outside temperatures, the presence of active sperm after a month can be correlated with the amount of subcutaneous fat; those that have been most active, as indicated by rereduction of stored fat, have very few or no sperm and scant uterine contents. The same generalizations can be made for *M. lucifugus* in which a few active sperm are recorded after an interval of from December 12 to February 8 in the animal room. Although these females were with males, there is little indication of insemination in the laboratory during these months in any of the observations. Two specimens which were in the animal room from January 16 until February 8 and in a warm room until February 17, and without males for the entire period, had active sperm even though their fat was exhausted. In one *Pipistrellus*, two active sperm were seen in the uterine contents after the animal had been in the laboratory, much of the time in the animal room, from December 12 until March 16.

Other changes that were noted in the tracts of these bats were the thickening of the uterine walls and the occurrence of secretion droplets in the contents examined. The method of study permitted no measurement of the walls, but in general the notation of villi was an indication

of the thickness of the endometrium and the growth of the glands. These so-called villi were entered in the records for some specimens throughout the winter; the secretion drops were rarely seen except when ovulation had occurred. In the autumn of 1932 secretion was observed in the tubes during the period of insemination.

It is not possible to say whether ovulation normally occurs without a spring insemination, but it does occur in *M. sodalis* under laboratory conditions when copulation has not been possible for over a week. In many of the earlier specimens in which ovulation had occurred, the egg was not seen or was in the one-cell stage. It is impossible to state whether development had been initiated. Furthermore, if these eggs are found, upon later study, to have been activated, it will not establish the function of sperm introduced in the autumn. Data presented elsewhere indicate that bats migrate as early as February 6 and after breaks in winter temperatures (Guthrie, 1933). Such a mild interval occurred in mid-January of 1932. Five specimens of *M. lucifugus* collected and killed on February 6, 1932, had conspicuous increase in follicular size, enlarged and active tubes; three had numerous active sperm in the tubes. These five individuals are probably to be interpreted as females entering or in a period of receptivity to males as a response to the seasonal variation. Such a period would correspond to an autumnal receptive period and could be followed by an ovulation if the follicle continued its growth under laboratory conditions. Under natural conditions, such bats would have re-entered a hibernating state.

As the breeding season approaches, the rapid elimination of autumnal sperm and leucocytes from the tract, conspicuous growth of follicles, and increasing ovulations after brief periods of captivity are noted. There are also two cases in *M. lucifugus* on March 16, where apparently insemination has recently occurred under laboratory conditions. On March 25, several specimens of *M. lucifugus* and *Pipistrellus* which died on the way to the laboratory, had apparently recently copulated. It was from the collection of April 2 that the typical situation was clarified. Some specimens examined immediately upon arrival at the laboratory still had a few sperm, as well as small leucocytes and large leucocytes with ingested sperm heads, in their uterine cavities and inactive sperm and masses in their vaginæ. Others had almost no inactive sperm but many active sperm in the uterine lumen, very few small leucocytes, no large leucocytes, scant vaginal sperm content and active sperm and leucocytes throughout the tubes. The tubes of all specimens were enlarged, but none had ovulated. These latter individuals had un-

doubtedly recently copulated, while the former group were either preparing for copulation or farther removed from the last period of acceptance. Five out of six females kept for three days had ovulated and were eliminating sperm and leucocytes through their vaginæ. The few specimens of *M. lucifugus* taken on April 18 were probably stragglers and gave no new information. However, all the *Pipistrellus* collected in April confirmed the hypothesis of an insemination at the time of ovulation and after the sperm and leucocytes of the previous insemination had been eliminated. It is probable that the tracts of the two specimens of *M. keenii* had been freed of sperm and leucocytes during their migration.

A few observations on tubal movements may be reported. In one specimen in which the follicle was rupturing, and in one in which the egg was in the upper third of the tube, a very pronounced contraction ring separated the upper two-thirds from the lower third of the tube. Segmentation does not occur when the egg is in the upper half of the tube but is very conspicuous in *M. lucifugus* as the egg nears the uterus. There is some indication that segmentation may occur at the time when the sperm are travelling up the tube in both *Pipistrellus* and *M. lucifugus*.

While insemination would seem to occur in the caves, as some of the bats become active during abnormal seasonal changes and as the normal breeding season approaches, ovulation must take place and gestation begin after the females leave the caves. After parturition, in *M. grisescens*, the tract is cleaned by means of leucocytes and muscular movements as it is after an insemination. Enlargement of the tubes follows, and in at least two individuals, ovulation occurred.

These observations show that bat sperm do remain active for unusually long periods in the tracts of the females. However, the data do not support the hypothesis that the sperm of the autumnal insemination are responsible for the vernal activation. Ample evidence for additional insemination periods is indicated and especially for one coincident with the normal time of ovulation. Until the cytological observations have been made, the use of the current terminology of the estrous cycle is deliberately avoided.

SUMMARY

1. Copulation in the species of bats studied occurs in the autumn before or as they enter the caves.

2. Copulation in the autumn is not conditioned by the presence of intermediate or large follicles.

3. Copulation may occur during the winter in bats that have been aroused from hibernation or have migrated as a result of abnormal seasonal changes.

4. Ovulation may follow such atypical copulation if bats are brought to the laboratory.

5. Copulation regularly occurs in the spring as the bats are aroused from hibernation.

6. Ovulation normally follows the spring copulation.

7. Ovulation does not normally occur until the bats leave the caves.

8. The period of acceptance of the male is characterized by the passage of leucocytes into the lumen of the reproductive tract of the female and by the enlargement of the tubes.

9. The sperm introduced in the autumn, in the atypical winter copulations, and the excess from the spring insemination, are in part ingested by leucocytes and in part eliminated through the vagina by muscular movements of the tract.

10. Sperm can remain alive in the uterus of the bat for at least a month.

11. The females of *M. grisescens* do not ripen follicles until their second spring but are inseminated at the end of their first summer.

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AUTUMN FOOD HABITS OF COYOTES, A REPORT OF PROGRESS, 1932

BY CHARLES C. SPERRY

This progress report on food habits of coyotes is based on the examination of 3,042 stomachs collected in 12 western States during September, October, and November, 1931 and 1932. Analyses were made in the Denver Laboratory of the Division of Food Habits Research of the U. S. Biological Survey. Of the 3,042 stomachs, 1,019 were empty and 570 contained débris only, leaving 1,453 on which an appraisal may be made of the coyote's diet during the fall of the year.

Examination of stomach contents should play an important part in any study of food habits. Such examinations may be made in the field or in a laboratory. In the past, field examinations of the contents of a great many coyote stomachs have been made by representatives of the Biological Survey, and some by other investigators, and information thus gathered has been used in publishing on the food habits of the animal. Field examinations, however, often are faulty in two respects, namely, as to correct identification of food items and as to the number of individuals in the prey represented. Field identifications of items are not invariably reliable even when made by experienced field biologists, a fact that has been proved a number of times by a reëxamination of the same material when laboratory facilities became available. That inconspicuous items in a stomach should be overlooked in a field examination is of course to be expected, for without laboratory advantages few of the minor items are detectable. This fact is glaringly evident in regard to percentage of occurrence of rodents, which is four times as great in the laboratory analyses as it is in those made in the field. In actual practice it is found that field examiners often recognize, or at least record, only one item per stomach, a manifestly incomplete result.

From the 1,453 recordable coyote stomachs that figure in the present study, taken during September, October, and November, the following

summary has been prepared on the basis of frequency of occurrence of the various items. The accompanying illustration, however, gives percentages by bulk. This method of appraisal has long been a standard one in the recording of data on the food of birds and numerous mammals, and, since the percentages of all items aggregate 100, charts or graphs may be easily prepared. It is often of greater importance, however, to determine the frequency with which the coyote indulges in certain feeding activities than to know the bulk of the food it consumes on such occasions. This is particularly true when considering the coyote's relation to livestock, poultry, and game. For that reason the following discourse will deal in terms of the frequency with which items have been found, while the figure presents volume estimates. Percentages representing frequency of occurrence tend to average greater than those recording volume, and, in the aggregate they will exceed 100. For instance, the percentage of volume of sheep and goats eaten is 14, while the frequency of occurrence for these same items is 22.

Rabbit.—Rabbits, as would be expected, are the most common of the coyote's captures. Jack rabbits, snowshoe rabbits, and cottontails, both old and young, are taken with seemingly no preference. Percentage of occurrence for rabbit remains varies from a low of 24 in the State of Washington to a high of 65 in Texas. The average for the 1,453 stomachs is 39 per cent.

Carrion.—Carrion was recorded 568 times in fall coyote stomachs, just 4 less than credited to rabbits. The volume contributed to the coyote diet by the two items is, as revealed in the chart, the same, each forming 29 per cent of the total food during September, October, and November. Under the heading "carrion" have been placed horse, burro, cow, coyote, and all known "station" material. By this last named term is meant the carcass of an animal used as a decoy to attract coyotes to the spot where traps or poison have been placed. The kinds of carcasses used for station material vary greatly, in accordance with field conditions and the trapping technique of individual hunters. In general, however, horse, cow, and coyote provide the bulk of station material, although some trappers get excellent results by using smaller animals, such as rabbits, prairie dogs, or marmots for bait. A slight error may be injected by classing as carrion all cow remains found in coyote stomachs. Some of this "cow" material may have been calf but from the available fragmentary remains in the stomachs they can not be recognized as having come from young animals. This error, however, is slight at most and is more than balanced by the number of sheep and goat

entries that might properly come under the carrion column, but cannot be placed there because of insufficient information concerning conditions under which the food was taken.

Domestic stock.—Sheep or goats occur in 22 per cent of the coyote stomachs. As previously indicated the domestic stock item would be somewhat changed if some of it were allocated to the carrion column where it probably belongs. Present practice is to debit sheep or goat against the coyote whenever a trace of wool is found in a stomach, except in the few cases where the presence of wool coincides with the use of a sheep carcass at a trap or poison station. On the other hand, calf, colt, or hog remains are rarely found in the stomachs of coyotes, having been recorded but 19 times in the total of 1,453.

Rodents.—Rodents, occurring in 33 per cent of the stomachs, occupy third place in the fall diet of the coyote. In this group have been recognized representatives of 8 families, namely, Cricetidae, Sciuridae, Heteromyidae, Geomyidae, Erethizontidae, Zapodidae, Aplodontidae, and Muridae—importance in the food being in the order named. It may be added that here lies the greatest difference in the results obtainable through field and laboratory stomach analyses. At best, field determinations in this group have been limited and devoid of fine distinctions. In the laboratory we have determined 9 genera of sciurids, while under "mouse or rat" 11 genera, representing 7 families, have been recorded. Leaders in the squirrel and "mouse or rat" groups are the prairie dog and white-footed mouse, with 53 and 115 records, respectively.

Miscellaneous animal food.—Badger and skunk each contributed 1 per cent, both in bulk and in frequency, to the coyote's autumn food. Just how much of either item may be carrion is not known. Mammals rarely taken by the coyote include moles, shrews, bats, weasels, and bobcats; there are single records each for mink, black-footed ferret, and gray fox.

Lizards and snakes occurred in 3 per cent of the fall coyote stomachs. The dominant item in this class is the spiny swift (*Sceloporus*), with 13 records; rattlesnake takes second place, with 6 records; and bullsnake third, with 5. Other reptiles, less frequently captured by coyotes, include horned-toads, sand swifts (*Uta*), garter snakes, racers, and turtles. There is a single record for a toad.

Insects, chiefly grasshoppers, were present in 8 per cent of the group of stomachs here reported upon, although seldom in sufficient quantity to form an appreciable part of the total contents.

Two coyotes from California, another from Washington, and a fourth from Arizona had eaten fish.

Birds.—Birds will be considered under three headings, namely, poultry, game birds, and other birds, because the majority of field and laboratory examinations so record them. Of the three, poultry is least common, being recorded but once in an average of 50 coyote stomachs.

Game birds were found in 4 per cent of the stomachs collected in fall months, and included 19 grouse, 7 quail, and 9 ducks.

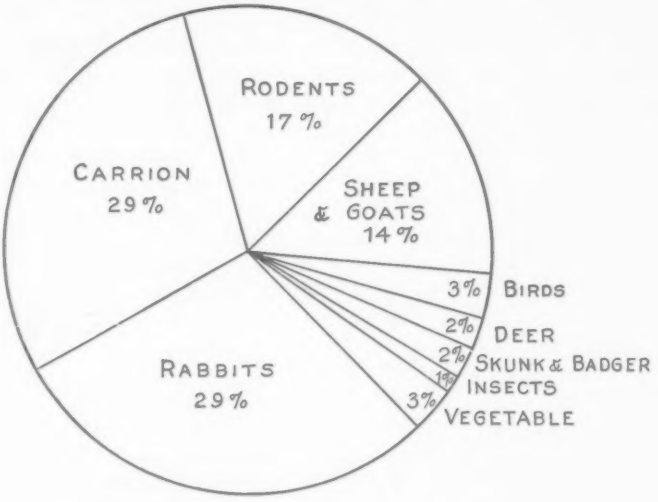

FIG. 1. CHIEF FOOD ITEMS OF THE COYOTE, PERCENTAGE BY BULK
Based on laboratory analyses of 1419 stomachs

A variety of other birds are eaten by coyotes. Our laboratory analyses show that nongame birds enter the diet of the coyote once in each 12 meals. Most of these are magpies, jays (with representatives of 4 genera), and meadowlarks. Other species, occurring two or more times in the 1,453 stomachs, include: Road-runner, red-shafted flicker, horned lark, raven, rock wren, robin, bluebird, and junco. Some magpies may be picked up dead about poison stations, while an occasional ground-feeding bird might easily become a coyote victim. Interesting, yet perplexing, however, are some of the problems of interpretation that

arise in connection with the avian food of the coyote. The presence of birds of such diversified habits as a Steller's jay and a meadowlark found in the same coyote stomach, may arouse some comment; but speculation is certain when the examination of a stomach discloses 3 such birds as an ant-eating woodpecker, a bluebird, and a junco with only a few feathers of each. Furthermore, who can explain the presence of 3 tail feathers of a rufous hummingbird, the only bird remains in a coyote stomach otherwise filled with rabbit?

Vegetable food.—The vegetable food of the coyote in fall is made up of fruits, berries, and seeds.

Cultivated fruit, although present in 3 per cent of the stomachs, is of little significance. Grapes, with 11 records, head the list; and figs are second, with 7. Other cultivated fruits occasionally taken by coyotes include apples, apricots, cherries, melons, pears, and prunes.

Wild fruits, berries, and seeds enter the coyote's autumnal diet twice as often as do cultivated varieties and frequently comprise the total meal of an individual. The important items among wild fruits are cactus fruits, with 26 records; thorn apples, with 17; and mesquite, with 15. One coyote consumed 440 thorn apples and another had fed on mesquite beans until his distended stomach held more than 1,100 seeds, mixed with a mass of pod fragments.

Grass is a rare food item of the coyote.

The Denver Laboratory of Food Habits Research is receiving regular shipments of stomachs of predatory mammals from members of the Biological Survey's Predatory Animal Control force in practically all the Western States, and the examination of contents is progressing at the rate of more than 500 a month. In the next progress report we hope to cover the food habits of the coyote during winter and spring months. We shall be glad to receive stomachs of all predatory mammals from any source and from any part of the country, including Alaska.

Denver Laboratory, Food Habits Research, U. S. Biological Survey.

REVISION OF THE JAGUARS

By E. W. Nelson and E. A. Goldman

The jaguars, the largest of American cats, are leopard-like in general appearance, but the larger size, more massive head and generally more robust form are distinguishing features. They inhabit the warmer parts of North and South America. There are records from California, northern New Mexico and well north in Texas, but the present range is from Arizona, southern New Mexico, and the Rio Grande Valley south to about 40° south in south-central Argentina. The common name, jaguar, now very generally applied to the animal, is derived from the South American Indian name "jaguara." The meaning of the name, according to Liais (Clim. Géol., Faune du Brésil, 1872, p. 450), is "carnivore that overcomes its prey at a single bound." In Brazil the jaguar was distinguished by the Portuguese as "onça verdadeira" (true ounce) or "onça pintada" (spotted ounce), from the puma, known as "onça parda" or "onça vermelha" (red ounce). In much of Latin America, however, these animals are now referred to, respectively, as the "tigre" and the "leon."

While the larger jaguars exceed the larger leopards in size and physical power and are very destructive to large animal life they are completely lacking in the ferocious aggressiveness sometimes shown by leopards in their encounters with man. In fact, the jaguars, although feared by natives in their tropical habitat, so rarely attack man that reports of such occurrences are very difficult to verify. In both North and South America they appear to have much the same shyness and dread of man as is shown by the puma or mountain lion, although they are claimed to be more dangerous in parts of South America.

It is doubtful whether any wild or domestic animal is safe from their onslaughts. Cattle, horses, and hogs are included in known jaguar depredations and many accounts indicate their special fondness for the flesh of peccaries. The large herds of white-lipped peccaries that roam tropical American forests are systematically followed and preyed upon by them. The great power and ferocity of their attacks are indicated by the fact that in 6 out of 92 skulls examined one or more of the canine teeth had been broken. In one instance all of the canines had been broken off short, and yet the animal, an adult male, had been able to subsist in spite of this handicap, as shown by the smoothly worn stubs. The broken canines suggest that these teeth, while fairly large, may be relatively weak for an animal with such powerful masseter muscles. In

the puma, on the other hand, the canines are rarely broken, but nasal and frontal contusions exhibited by a considerable number are evidently the result of mishaps in bringing down their prey.

Since the time of Azara (Apunt. Hist. Nat. Quad. del Paragüay, vol. 1, pp. 89–91, 1802) the question of the number of species of jaguars has been discussed. Azara referred to a belief of some of the people that two normally colored kinds of jaguar occur in the region. One of these was called the "yagüareté" and the other, the "yagüareté-popé," was thought to be of heavier proportions, and to differ in general color and arrangement of spots. The latter was also regarded by some as a fiercer animal and more dangerous to man. Azara, however, with his usual accurate appraisal of evidence discredited this belief and recognized only one kind, aside from the black phase of the jaguar, or "yagüareté negro," and his conclusions have been supported by more recent information. The concept of two kinds, based apparently upon individual variation, led to the naming of *Felis onca major* and *Felis onca minor* by Fischer.

The present brief outline of the relationships of the jaguars is the result of a study of material available in the principal North American museums, including the types of most of the described forms. Probably for the first time specimens of the jaguar have been assembled in sufficient series to give a clear concept of the ranges of individual, sexual, age and geographic variations. A total of 101 specimens have been examined, as follows: 35 skins and skulls, 57 skulls without skins and 9 skins without skulls. This is, however, far too small a number for an exhaustive revision, and some of the forms remain very imperfectly known. The geographic ranges of the forms are given as definitely as possible, but are of course very incomplete. A remarkable uniformity in the more essential characters of jaguars, regardless of locality, forces the conclusion that all are assignable to a single species. The ground color, and the size and arrangement of spots are so variable that little dependence can be placed upon them as characters, although slight average differences of subspecific value are presented in some cases.

Changes in size and minor cranial details from region to region are fairly constant, however, and serve to differentiate the various closely allied and obviously intergrading geographic races. Regional modifications, especially in size, are more irregular than in the puma, in which they are quite uniformly progressive from the largest subspecies in the northern Rocky Mountains through small tropical representatives to another large subspecies in southern Argentina. In the jaguars small subspecies may occur in close proximity to larger ones. An example is

Felis onca goldmani of Campeche, Mexico, the smallest of jaguars, which is replaced in the neighboring states of Tabasco and Vera Cruz by a much larger animal.

For the loan of specimens we are greatly indebted to Mr. H. E. Anthony, American Museum of Natural History, New York City; Dr. W. H. Osgood, Field Museum of Natural History, Chicago, Illinois; Mr. F. W. Miller, Colorado Museum of Natural History, Denver, Colorado; Dr. G. M. Allen, Museum of Comparative Zoology, Cambridge, Mass.; Mr. J. Kenneth Doutt, Carnegie Museum, Pittsburgh, Pennsylvania; Mr. John M. Phillips of Pittsburgh, and to Mr. Charles M. B. Cadwalader and Mr. James A. G. Rehn, Academy of Natural Sciences, Philadelphia, for especially valuable material obtained by the Matto Grosso Expedition in Southern Brazil.

Specimens examined, unless otherwise indicated, are in the United States National Museum.

Felis onca Linné

[References under subspecies]

Distribution.—Nearly transcontinental; found at the lower altitudes from the Grand Canyon, Arizona, southern New Mexico, and central Texas south at least to the Parana Valley, central Argentina. Mainly tropical in dispersal; not usually ascending into the colder belts at high altitudes.

General characters.—Size large—the largest of American cats. Form robust. Tail relatively short and tapering. Ears small, short and rounded, without elongated terminal tufts. Pelage short and rather bristly. Upper parts profusely spotted at all ages. Similar in general appearance to *Felis pardus* of the Old World, but differing notably as follows: Form more robust; skull presenting differential details, especially the relatively shorter canines; lower canines scarcely reaching plane of lower border of anterior nares (in *pardus* reaching well above this plane); canine longitudinal grooves absent or obsolescent; tail shorter and tapering; large pads, especially on soles of front feet, more evenly rounded; black rings outlining spots or rosettes similar to those of *F. pardus*, those on sides tending to enclose one or more small black spots (usually absent in *pardus*).

Color.—Ground color of upper parts varying from light ochraceous buff or pale straw color to light golden tawny or tan color, nearly uniform over median dorsal area from top of head to base of tail, becoming gradually paler to near cinnamon buff or light buff on cheeks, sides of neck, lower part of flanks and outer surfaces of legs; body in general heavily spotted with black; dorsum, except median line on posterior part of back and sides, marked by irregularly circular or crescentic or broken spots that tend to form rosettes or enclose smaller spots in a darker field than the general ground color; median line on posterior part of back bearing elongated, solid black spots that tend to present an irregular lateral paired arrangement or to become confluent; top and sides of head, neck, and feet marked by smaller black spots; under parts and inner surfaces of legs white,

heavily spotted with black; throat, under side of neck and inner sides of forelegs marked with more or less confluent black spots that tend to form transverse bars; upper surface of muzzle varying from pinkish buff to clay color, unspotted; cheeks, forehead, and feet with small, rounded black spots; upper and lower lips white near middle, becoming abruptly black toward angles of mouth; outer sides of ears deep black, with small buffy median spots; inner sides of ears thinly clothed with whitish hairs; tail with crowded, irregular black markings, separated on basal half above by narrow pinkish buffy or cinnamon buffy interspaces, becoming white below and toward tip, which is usually black. Some of the subspecies average darker than others; in some individuals the ground color is darker and richer than in others from the same locality. Average differences in the size and form of rosettes may be of subspecific value, but individual variation is extraordinary. No two animals are exactly alike and the spots may differ even on the right and left sides of the same individual.

Remarks.—Felis onca is subdivisible into very closely allied subspecies or geographic races. The males are larger than the females but males of a small form may be exceeded in size by females of a large form. In addition to larger sizes, as compared with females, the skulls of males are usually recognizable by their angularity, especially the greater development of the sagittal and lambdoid crests. Individual variation covers a wide range and adds to the difficulty of making accurate identifications. The most reliable distinguishing characters for the various subspecies are the differing combinations of size and cranial details as presented by average individuals. The following features are subject to important modifications: Form of the skull in upper outline; height and inflation of frontal region; width of rostrum; form of nasals; development of lambdoid crest; width and depth of interpterygoid fossa; form of audital bullae (with allowance for great individual variation); and size of teeth, especially the canines.

Felis onca onca Linné

East Brazilian Jaguar

[Felis] *onca* Linné, Syst. Nat., ed. 10, vol. 1, 1758, p. 42.

Type locality.—Pernambuco (now Récife), Brazil (fixed by Thomas, Proc. Zool. Soc. London, 1910, p. 136, Mar., 1911).

Distribution.—Extreme eastern Brazil west and north to the lower Amazon.

General characters.—A large subspecies approaching *paraguensis*, but skull smaller; frontal region less elevated behind postorbital processes; temporal ridges tending to unite to form the sagittal crest farther anteriorly; sagittal and lambdoid crests strongly developed, much as in *paraguensis;* audital bullae more fully inflated; dentition heavy. Compared with *major* of Surinam the skull is decidedly larger, with relatively much more prominent sagittal and lambdoid crests. The original description of *mexianae* indicates that the skull of typical *onca* differs from it in larger size and probably in other details. For cranial measurements see table, p. 232.

Remarks.—F. onca was based by Linné upon early accounts of the jaguar in Brazil. Of the species he merely says, "*Habitat* in America Meridionali." Unfortunately no specimens from near the type locality of *onca*, as fixed by Thomas, are available for our study. In the absence of such material we have

regarded skulls from the valley of the Rio Tocantins as the most likely, among those at hand, to represent this form, and have used them as a basis for comparisons.

Measurements.—No external measurements available. *Skull* (see table, p. 232).

Specimens examined.—Three, from Brazil, as follows:

PARA: Lower Amazon, 1 (skull only[1]); Tocantins River Valley, 2 (skulls only).

Felis onca coxi, subsp. nov.

Espiritu Santo Jaguar

Type.—From north of Rio Doce, Espiritu Santo, Brazil. No. 256388 [♀ ad.], skull only, U. S. National Museum, collected by W. T. Cox, 1931.

Distribution.—Eastern Minas Geraes and Espiritu Santo, Brazil; limits of range unknown.

General characters.—A small, light buffy or straw-colored subspecies. Much smaller than its geographic neighbors, typical *onca* or the Matto Grosso animal, described beyond, resembling the latter in color but differing from both in cranial details.

Color.—Skin from upper Rio Doce, Minas Geraes: Ground color of upper parts in general light ochraceous buff or yellowish straw color, slightly darker within the rosettes than in the interspaces, becoming still paler, less yellowish, and near light buff on sides of neck, flanks, and outer surfaces of legs; black spots and rosettes rather large and heavy, some enclosing smaller spots as in the other forms; black spots large, irregular, and partly confluent along median line on posterior part of back; under parts and inner surfaces of legs white, heavily spotted with black; tail with irregular heavy black markings throughout its length, separated by narrow interspaces, light buffy near base above, becoming white thinly mixed with black toward tip and white below.

Skull.—Cranium small, with a low sagittai crest and well-developed lambdoid crest. Compared with that of subspecies *onca* the skull is much smaller; frontal region more constricted immediately behind postorbital processes; bullae relatively broader, somewhat flatter posteriorly near line of contact with exoccipitals. Very much smaller, less angular than that of *F. o. milleri*, the Matto Grosso jaguar; frontal region much less highly arched, the sides most deeply constricted immediately behind postorbital processes (sides of frontals inflated behind postorbital processes in Matto Grosso form); fronto-parietal suture more evenly transverse instead of forming a narrow V pointing forward on the median line.

Measurements.—Flat tanned skin from upper Rio Doce, Minas Geraes: Total length, 2190 mm.; tail, 565. *Skull* (see table, p. 232).

Remarks.—F. o. coxi contrasts strongly in size with its much larger geographic neighbors in the Parana and Paraguay river valleys. Two skulls received many years ago from Herman von Ihering, and probably taken in the general vicinity of São Paulo, were at first assigned here but seem referable to the form described on p. 228. This new subspecies is named for the collector of the type, Mr. W. T. Cox, in recognition of his extensive studies of wild life.

Specimens examined.—Total number, 4, as follows:

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[1] Collection Amer. Mus. Nat. Hist.

MINAS GERAES: Near Rio Doce, near eastern part of state, 1 (skull only); upper Rio Doce, 1 (skin only).
ESPIRITU SANTO: North of Rio Doce (type locality), 2.

Felis onca milleri, subsp. nov.

Matto Grosso Jaguar

Type.—From Descalvados, Matto Grosso, Brazil. No. 26552, ♀ adult, skin and skull, Field Museum of Natural History, collected by Mrs. Marshall Field, August 4, 1926.

Distribution.—Upper part of Paraguay River Valley, in southwestern Brazil and southeastern Bolivia.

General characters.—One of the largest of the jaguars—about equalling *paraguensis*. Ground color of upper parts pale—near light ochraceous buff. Skull larger than in *onca*, and differing in detail. Much larger than *coxi* of southeastern Brazil.

Color.—Type: Ground color of upper parts in general, including outer surfaces of forelegs and thighs, light ochraceous buff, slightly darker in tone within the rosettes than in the interspaces, paling to near light buff on sides of neck, flanks, and feet; black rings of rosettes large and most of them broken, enclosing one to four or five small black spots; black spots narrow and elongated along median line of back posteriorly; black spots on head and outer sides of legs large; under parts and inner surfaces of legs white, interrupted by large irregular black spots; tail with irregular heavy black markings, separated by narrow interspaces, ground color light ochraceous buff near base above, becoming white thinly mixed with black toward tip, and white below. In a very young individual from Corumbá, Brazil, the spots on the upper parts are angular and closely crowded leaving uniformly narrow interspaces and forming a well defined, reticulated pattern.

Skull.—Closely resembling that of *paraguensis* in large size, massiveness and angularity, but upper outline more arched, rising higher behind postorbital processes; frontal region broader and higher, the sides more expanded below temporal ridges; posterior nares and interpterygoid fossa narrower and deeper, the interpterygoid space more deeply concave as viewed from below; nasals broader, the anterior ends usually more divergent, narrowing more abruptly posteriorly; parietals developed forward and encroaching farther on frontals along sagittal crest than in most subspecies; dentition similar to *paraguensis* but molariform teeth rather light. Compared with *onca* the skull is larger; frontal region more elevated behind postorbital processes, the sides distended and bulging more prominently below temporal ridges; temporal ridges tending to unite to form the sagittal crest farther posteriorly; sagittal and lambdoid crests strongly developed, as in *onca;* audital bullae less fully inflated; dentition similar. Compared with that of *coxi*, the skull is much larger; frontal region more highly arched, the sides constricted farther posteriorly near fronto-parietal suture.

Measurements.—Type (tanned skin): Total length, 1880 mm.; tail, 475. *Skull* (see table, p. 232). An adult male topotype (in flesh): Total length, 2419 mm.; tail vertebrae, 665; hind foot, 302. Another adult male topotype: Weight (on platform scale), 290 lbs. An adult female topotype (in flesh): Total length, 2116 mm.; tail vertebrae, 604; hind foot, 255.

Remarks.—As the geographic range of the present form closely adjoins that of *paraguensis* the cranial peculiarities noted are remarkable. This case is paralleled, however, by similarly abrupt modification of characters along geographic lines elsewhere. The new subspecies is named for Mr. F. W. Miller who, in connection with his work for the Colorado Museum of Natural History, has made an important contribution to knowledge of the mammals of southern Matto Grosso. Mr. Miller referred specimens from Descalvados to *F. ramsayi*, which he proposed as a substitute name for *F. paraguensis* as indicated in our remarks under that form.

Specimens examined.—Total number, 19, all from Matto Grosso, Brazil as follows:

Corumbá, 5 (2, skulls only); [2]Descalvados, 13; [3]Lake Uberaba (on boundary between Brazil and Bolivia), 1 (skull only).

Felis onca paraguensis Hollister

Paraguay Jaguar

Felis paraguensis Hollister, Proc. U. S. Nat. Mus., vol. 48, p. 169, Dec. 16, 1914 (1915). Type No. 4128, [♂] adult, U. S. National Museum, collected by Capt. T. J. Page, about 1860.

Felis notialis Hollister, Proc. U. S. Nat. Mus., vol. 48, p. 170, Dec. 16, 1914 (1915). Type from San José, Entre Rios, Argentina, No. 4361, [♀] adult, U. S. National Museum, collected by Capt. T. J. Page, August, 1860.

Felis ramsayi F. W. Miller, Journ. Mamm., vol. 11, no. 1, p. 14, Feb. 11, 1930. Substitute name for *F. paraguensis*.

Felis o[nca] paraguensis Barbour, Records North Amer. Big Game, Dec., 1932, p. 155.

Type locality.—Paraguay.

Distribution.—Paraguay, adjoining part of Parana River Valley, Brazil, and northeastern Argentina.

General characters.—One of the largest of the jaguars. Color undetermined but probably similar to *milleri*. Skull about like that of *milleri* in size and angularity, but frontals less elevated behind postorbital processes, the sides less expanded below temporal ridges; posterior nares and interpterygoid fossa wider and shallower, the interpterygoid space less deeply concave; nasals narrower, tapering more gradually to posterior ends; dentition similar but molariform teeth rather heavy.

Measurements.—No external measurements available. Skull (see table, p. 232).

Remarks.—No skins of *paraguensis* have been examined by us and the color, therefore, has not been determined. *F. notialis* was based upon a skull regarded by the describer as that of a male, but which, with the advantage of more material for comparison appears to us to be that of a female. It agrees closely in essential characters with the type of *paraguensis*. *Felis ramsayi*, was proposed by F. W. Miller as a substitute name for *Felis paraguensis* on the ground that the latter

[2] Collection Amer. Mus. Nat. Hist.

[3] One in Field Mus. Nat. Hist.; 3 in Colorado Mus. Nat. Hist.; 9 in Acad. Nat. Sci. Phila.

was preoccupied by *Panthera paragayensis*. This name, however, was applied to an ocelot by Oken in 1816. A substitute name takes the same type specimen as that of the name replaced and therefore *F. ramsayi* has the same type as *F. paraguensis*. Oken consistently wrote "Paragay" for Paraguay and the differently-formed derivatives from such different names are not regarded by us as synonymous. *F. ramsayi* is therefore a synonym of *F. paraguensis*.

Specimens examined.—Total number, 4, as follows:

ARGENTINA: San José, Entre Rios, 1 (skull only—type of *notialis*).

BRAZIL: Campo Grande, Matto Grosso, 1 (skull only).

PARAGUAY: Puerto Pinasco, 170 kilometers west of Riacho Salado (in disputed territory), 1 (skull only); without definite locality, 1 (skull only—type).

Felis onca paulensis, subsp. nov.

Southeast Brazilian Jaguar

Type.—São Paulo region, southeastern Brazil (exact locality undetermined). No. 100123, [♀] adult, skull only, U. S. National Museum (Biological Survey collection), received from Herman von Ihering, June, 1900.

Distribution.—São Paulo region; probably widely distributed in southeastern Brazil.

General characters.—Size very large—about as in *milleri* and *paraguensis*, but differing in cranial details from both. Differing from *coxi* most notably in much larger size.

Color.—Undetermined.

Skull.—Closely approaching that of *coxi* in general form, but much larger, more massive and angular; sagittal crest much more strongly developed; temporal ridges more abruptly curved inward, uniting to form the sagittal crest farther forward. Similar in size and angularity to *milleri* and *paraguensis*, including the prominent sagittal and lambdoid crests, and dentition about the same. Distinguished from *milleri* by much narrower, less distended frontal region immediately behind postorbital processes; temporal ridges more abruptly curved inward, uniting to form the sagittal crest farther forward; interpterygoid fossa similarly narrow, but shallower. Differing from *paraguensis* in broader frontal region behind postorbital processes; bony palate decidedly narrower in front of interpterygoid fossa, interpterygoid fossa narrower, but deeper.

Measurements.—No external measurements available. *Skull* (type): Greatest length, 266.2; condylobasal length, 235.5; zygomatic breadth, 175.4; width of rostrum (behind canines), 70.5; interorbital constriction, 47.7; width across mastoid processes, 111.5; width of interpterygoid fossa, 23.8; upper canine-premolar series (alveoli), 76.3; crown length upper carnassial, 26.6; diameter upper canine (antero-posterior), 20.8.

Remarks.—*Felis onca paulensis* is based upon three skulls—one of an adult male in the Academy of Natural Sciences of Philadelphia, labelled São Paulo, and received from E. D. Cope many years ago, and two adult females in the U. S. National Museum, from the general region, received in June, 1900, from Herman von Ihering. This material is unsatisfactory, owing to the lack of more exact locality data, but the three skulls agree so closely among themselves, and differ

collectively so uniformly in important details from the neighboring forms that subspecific recognition seems warranted. Unfortunately no skins are available and the color must be left for later determination.

Felis onca boliviensis, subsp. nov.

Bolivian Jaguar

Type.—From Buena Vista, Santa Cruz, Bolivia. No. 34344, [♂] adult, skin and skull, Field Museum of Natural History, collected by J. Steinbach in 1924. Original number 1462.

Distribution.—Lower eastern slopes of Andes in central Bolivia, limits of range unknown.

General characters.—Similar in general to *milleri* but smaller and ground color of upper parts darker and richer in tone; cranial characters distinctive. Apparently differing from the little known form *peruviana*, of the coast region of Peru, in cranial details, especially the more oblique position of the paroccipital and mastoid processes.

Color.—Type: Ground color of upper parts in general, including outer surfaces of forelegs and thighs, near cinnamon buff, slightly darker in tone within the rosettes than in the interspaces, becoming paler buff on sides of neck, flanks, and on feet, the ground color along sides of body fading gradually into white of under parts; rosettes large and forming numerous complete circles or rings, but narrowly outlined, most of them enclosing one to four or five smaller spots; black spots on head and outer sides of legs of medium size; under parts and inner surfaces of legs white, with the large black spots or irregular blotches usual in the group; tail with irregular black markings, separated by narrow interspaces, light cinnamon buff near base above, becoming white thinly mixed with black toward tip, and white below. In a topotype the ground color above is of a brighter, richer cinnamon buff than in the type.

Skull.—Similar in general to that of *milleri*, but smaller, with upper outline more evenly arched; frontal region narrower, higher, more convex in front of postorbital processes, less elevated and less bulging laterally as well as upward behind postorbital processes; postorbital constriction near postorbital processes instead of farther posteriorly near fronto-parietal suture as in *milleri;* crown of carnassials, above and below, actually longer, therefore relatively decidedly longer, measured antero-posteriorly; canines about the same. Apparently differing from *peruviana* in the flatter, less highly arched upper outline; postorbital constriction nearer postorbital processes; paroccipital and mastoid processes more oblique in relation to axis of skull (paroccipital and mastoid processes in more nearly the same transverse plane in *peruviana* as shown in Blainville's plate illustration of the type); nasals broader.

Measurements.—Type (tanned skin): Total length, 2055 mm.; tail, 610. *Skull* (see table, p. 232).

Remarks.—In view of geographical contiguity *boliviensis* exhibits a surprising departure from *milleri* in cranial details and the more vivid color of the upper parts seems to be distinctive. No specimens of *peruviana* are available, and the exact relationship of *boliviensis* to that form remains to be determined. *F. boliviensis* differs, however, from Blainville's figures of the skull of the type of

peruviana, and the great range of geographic variation in the species would argue against the occurrence of the same forms east and west of the great wall of the Andes.

Specimens examined.—Three[4] (3 skins and 2 skulls), from the type locality.

Felis onca peruviana Blainville

Peruvian Jaguar

Felis onca peruviana Blainville, Ostéog. Icon. Mamm. Réc. et Foss., vol. 2, fasc. 12, genre *Felis*, p. 186; ibid., atlas, pl. 8, 1843.

Type locality.—Peru (probably from the coast region).

Distribution.—Believed to be the coastal region of Peru; limits of range unknown.

General characters.—Apparently a rather large subspecies with paroccipital and mastoid processes in more nearly the same transverse plane in relation to longitudinal axis of skull than in the other forms; frontal region broad, constricted posteriorly; nasals narrow, evenly tapering to an acute point posteriorly.

Remarks.—Blainville (l.c.) in explanation of the plate illustrations of the skull of the jaguar accompanying his work used the name *F. onca*, without description, for several figures, including the profile and upper and lower views of the cranium of a female from Peru. Under the Peruvian figures on the plate, however, is the legend "*F. onca peruviana* ♀," which seems to provide a valid name for a Peruvian subspecies. The animal was given alive to the menagerie by Rear Admiral d'Urville and, therefore, probably came from the coast region. In view of the general principles that govern geographic distribution of species it is unlikely that the same subspecies occurs to the east and west of the Andes, which, rising like a great wall, probably bars the easy passage of these great cats from one side to the other. Blainville's figures indicate cranial peculiarities, but were drawn from a menagerie animal and may not be entirely trustworthy. As no specimens of *peruviana* are available its exact relationship to the other subspecies remains to be determined.

Felis onca ucayalae, subsp. nov.

Upper Amazon Valley Jaguar

Type.—From Sarayacu, Rio Ucayali, Peru. No. 76451, ♂ adult, skin and skull, American Museum of Natural History; collected by the Olalla brothers, May 1, 1927.

Distribution.—Ucayali and Marañon river valleys, northeastern Peru, and probably beyond in neighboring parts of the upper Amazon drainage.

General characters.—Similar to *boliviensis*, but larger; rosettes heavily outlined and black spots on head, limbs, and under parts larger than usual in the species; skull differing from those of *onca* and *boliviensis* in detail, especially the narrowly spreading zygomata. Apparently differing from *peruviana* in cranial features.

Color.—*Type:* Ground color of upper parts in general near cinnamon buff; rosettes large and heavy, several of those in the mid-dorsal region with unbroken

[4] Collection Field Mus. Nat. Hist.

outlines, enclosing one or two small black spots; black spots on head, legs and under parts very large.

Skull.—Similar to that of *boliviensis*, but larger, more elongated; zygomata relatively less widely spreading; squamosal arm of zygoma more strongly developed; rostrum broader; temporal ridges more abruptly curved inward, and uniting to form a sagittal crest farther anteriorly; dentition similar. Apparently differing from *peruviana* in broader nasals, more abruptly narrowing near posterior ends, and in more oblique mastoid and paroccipital processes in relation to axis of skull. Compared with that of *major* the skull is larger; zygomata relatively less widely spreading; frontal region narrower; lambdoid crest much broader, more strongly developed; dentition heavier.

Measurements.—*Type* (tanned skin): Total length, 1982 mm.; tail, 523. *Skull* (see table, p. 232).

Remarks.—*F. o. ucayalae* is based mainly on a fine male specimen which we have been unable to refer to any other form. The skull differs from Blainville's plate illustration of *peruviana* which presumably came from west of the great wall of the Andes, but the exact relationship of *ucayalae* to that subspecies must be left for later determination. A skull from Moyobamba is very doubtfully included here, as it exhibits a departure especially in the shallow depth of the interpterygoid fossa, a character similar to that of the geographically distant form *paraguensis*. In a skin from Rio Napo the rosettes are more broken and the small enclosed black spots are more numerous than in the type.

Specimens examined.—Three, all from Peru,[6] as follows:

Rio Napo (near Iquitos), 1 (skin only); Moyobamba, 1 (skull only); Sarayacu, Rio Ucayali, 1 (type).

Felis onca major Fischer

Surinam Jaguar

[*Felis onca*] *major* Fischer, Syn. Mamm., Addenda, 1830, p. 366 (= 566).

Type locality.—Surinam.

Distribution.—Northern South America from Surinam west through British Guiana and extreme northern Brazil to western Venezuela.

General characters.—A medium sized cinnamon buffy subspecies, with outer rings of rosettes usually broken, but irregularly encircling one to four or five small black spots; skull with a narrow, weakly developed lambdoid crest combined with rather heavy dentition. Skull smaller than that of *onca*, with much less prominent sagittal and lambdoid crests. Ground color of upper parts about as in *ucayalae*, but rosettes more broken than in the type of the latter; skull smaller, with relatively reduced lambdoid crest and more widely spreading zygomata. Similar in color to *centralis*; skull larger with decidedly heavier dentition and less strongly developed lambdoid crest.

Measurements.—An adult male from Serra da Lua, Amazonas, Brazil: Total length, 1775 mm.; tail vertebrae, 583; hind foot, 240. *Skull* (see table, p. 232).

Remarks.—The name *major* was based by Fischer on the "Jaguar, great var." of Hamilton Smith (Griffith, in Cuvier's Anim. King., vol. 2, p. 455, and colored

[6] Coll. Field Mus. Nat. Hist.

TABLE 1

Cranial measurements of jaguars (all measurements in millimeters)

SUBSPECIES	LOCALITY	NUMBER	GREATEST LENGTH	CONDYLOBASAL LENGTH	ZYGOMATIC BREADTH	WIDTH OF ROSTRUM (BEHIND CANINES)	INTERORBITAL CONSTRICTION	WIDTH ACROSS MASTOID PROCESSES	WIDTH OF INTERPTERYGOID FOSSA	UPPER CANINE-PREMOLAR SERIES (ALVEOLI)	CROWN LENGTH UPPER CARNASSIAL	DIAMETER UPPER CANINE (ANTERO-POSTERIOR)
Adult males												
Felis onca onca	Brazil: Tocantins Valley, Para	256385	296.3	253.5	204.8	76.6	57.5	125.8	28.1	81.8	28.5	22
Felis onca milleri	Brazil: Corumbá, Matto Grosso	37503[a]	302	277	207	80.5	57		22	86.4	28.2	22.8
Felis onca paraguensis	Paraguay	4128[b]	295.5	264	195	77.5	55.5	122.2	29.2	83.5	29	21
Felis onca boliviensis	Bolivia: Buena Vista, Santa Cruz	34344[b,c]	266	236.5	175.5	68.2	47	112.5	21.1	81.5	28.5	21
Felis onca ucayalae	Peru: Sarayacu, Rio Ucayali	76451[a,b]	274.9	245.5	173.8	73.9	49.4	112.2	22.1	78	29.2	20.8
Felis onca major	Surinam	9505[d]	264	241.9	182.3	73.9	54.4	111	24.2	82	28.7	20.7
Felis onca mexianae	Brazil: Mexiana Island				180						28	
Felis onca centralis	Costa Rica: Talamanca	14177[b]	250.5	219.5	169.5	63.8	41.5	101	22.3	72.5	25.5	20
Felis onca goldmani	Guatemala: Laguna El Sotz, Peten	249823	237.5	217.8	166.5	64.9	44	100.5	21.3	72	23.5	19
Felis onca hernandesii	Mexico: Agua Brava, Sinaloa	25008			177.5	72	53.5	107.5	21.6	74.2	26.8	18.4
Felis onca veraecrucis	Mexico: San Andres Tuxtla, Vera Cruz	67403[b]	279	247.4	180	72.3	50	111.7	23	77.5	28	21.3
Felis onca arizonensis	Arizona: Cibecue	244507[b]	273	237.5	187	74.5	51	111.5	20	81	28	20.4
Adult females												
Felis onca coxi	Brazil: North of Rio Doce, Espiritu Santo	256388[b]	219.5	198.4	149.4	58.5	43	91	20	67.3	24.1	16.1
Felis onca milleri	Brazil: Descalvados, Matto Grosso	26552[b,c]	267.8	238	175.4	70.3	51.5	110.9	23.9	77.5	27.8	20
Felis onca paraguensis	Argentina: San José, Entre Rios	4361	261	232.3	175.5	72.3	43.8	107.8	27.8	79	30.8	20.8
Felis onca boliviensis	Bolivia: Buena Vista, Santa Cruz	21378[c]	242.4	212	160	65.8	47	97.3	24.6	74.5	28.5	18.8
Felis onca major	Venezuela: Caura Valley	137039	239	214.3	163.3	65.5	47	101.4	24.1	71	27.7	18.1
Felis onca mexianae	Brazil: Mexiana Island				160						25.8	
Felis onca madeirae	Brazil: Auará Igarapé, Rio Madeira	91702[a,b]	224	203	150.5	62	44.7	95.7	19.5	70.3	25.7	17.4
Felis onca centralis	Salvador: Conchagua Volcano	8003	231.5	207.7	156.2	63.5	43.8	99	21.9	71.3	25.9	17
Felis onca goldmani	Campeche: La Tuxpeña, Champoton	179171	204	187.8	143.8	55	38.8	85.5	20	64.9	24.4	16.7
Felis onca hernandesii	Mexico: Near Colima, Colima	6480	218.8	199.5	154.8	62.6	44.8	93.1	20.8	70.1	25.8	18
Felis onca arizonensis	Arizona: Greaterville	231961	217.5	192.4	155.3	64.6	44.3	96	21.3	68.8	25.1	16.4

[a] Coll. Amer. Mus. Nat. Hist.
[b] Type.
[c] Coll. Field Mus. Nat. Nist.
[d] Coll. Mus. Comp. Zool.

text fig., 1827). While in America Hamilton Smith, according to Griffith, "satisfied himself there were two distinct varieties of the Jaguar, differing principally in dimensions." One of his two figures, drawn from an animal from Surinam, bears the legend "The Jaguar, Great var? F. onca L." The other (l.c., colored text fig. opposite p. 456) representing a smaller, paler animal from America, but without definite locality, is inscribed "The Jaguar. Small or common var. F. onca L." On the latter Fischer founded [*Felis onca*] *minor*. As the name *major* was clearly applied to Smith's figure of an animal from Surinam it may be accepted as valid for the form inhabiting that country. The name *minor* of Fischer, however, without locality is unidentifiable.

Specimens examined.—Total number, 12, as follows:

BRAZIL: Frechal, Rio Surumu, 1;[6] Serra da Lua (near Bôa Vista), 3 (skulls only).[7]

BRITISH GUIANA: Georgetown, 1 (skull only);[7] Kartabo, 1.[6]

SURINAM: Without definite locality, 1 (skull only).[8]

VENEZUELA: Caura Valley, 1; Maracaibo (market), 2 (1 skin only; 1 skull only);[7] Maripa, 1;[6] Rio Orinoco (mouth of Rio Ocamo), 1 (skull only).[6]

Felis onca mexianae Hagmann

Mexiana Island Jaguar

Felis onca var. *mexianae* Hagmann, Archiv. Rassen- und Gesellsch.-Biologie, vol. 5, p. 10, Jan.-Mar., 1908. Type in Strassburg Museum.

Type locality.—Mexiana Island, estuary of Amazon River, Brazil.

Distribution.—Known only from Mexiana Island.

General characters.—Described as smaller than mainland animals from the vicinity of the Rio Tapajoz and southern Brazil. Skull measurements of largest adult male and female, respectively (from original description): Basilar length, 210 and 186 mm.; zygomatic breadth, 180 and 160; width across maxillae over canines, 70 and 64; length of upper carnassial, 28 and 25.8.

Remarks.—*F. o. mexianae* was based upon seven skulls from Mexiana Island. The measurements indicate a smaller animal than that of the adjacent mainland, but no specimens have been examined by us and the exact relationship to the other forms remains to be determined. As Mexiana is one of the outer islands in the estuary of the Amazon the occurrence of a small jaguar there suggests that the same or a similar form may inhabit other islands in the delta of the river.

Felis onca madeirae, subsp. nov.

Rio Madeira Jaguar

Type.—From Auará Igarapé (above Borba), Rio Madeira, Amazonas, Brazil, No. 91702, ♀ adult, skin and skull, American Museum of Natural History; collected by Olalla brothers, March 15, 1930. Original number 1991.

Distribution.—Valley of the Rio Madeira; limits of range unknown.

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[6] Coll. Amer. Mus. Nat. Hist.

[7] Coll. Field Mus. Nat. Hist.

[8] Coll. Mus. Comp. Zool.

General characters.—A small, rather rich cinnamon buff subspecies; black rings of rosettes heavily outlined in the type, and enclosing a few small black spots. Similar in general to *onca*, but decidedly smaller. Not very unlike *coxi* but larger, darker, and richer in general color, and cranial characters distinctive. Differing from *major* in smaller size and cranial details, especially in the relatively greater development of the lambdoid crest.

Color.—Type: Ground color of upper parts in general near cinnamon buff, very slightly darker within the rosettes than in the interspaces; rosettes of medium size, heavily outlined, a few near mid-dorsal area irregular in form, completely closed, others consisting of nearly closed rings; three or four only containing each a single small black central spot; black spots on head, legs, and under parts of medium size.

Skull.—Similar to that of *onca* but decidedly smaller, less arched in upper outline; frontal region flatter; interpterygoid fossa very narrow; dentition light. Much smaller than that of *major*, with relatively broader, more strongly projecting lambdoid crest; interpterygoid fossa relatively narrower; dentition relatively lighter. Similar in general to that of *coxi*, but larger; interpterygoid fossa actually as well as relatively narrower; dentition much heavier.

Measurements.—Type (tanned skin): Total length, 1610 mm.; tail, 465. *Skull* (see table, p. 232).

Remarks.—The present form is based on a single specimen from near the center of the great valley of the Amazon. While close relationship to neighboring forms is indicated the characters pointed out seem to warrant subspecific recognition.

Felis onca centralis Mearns

Central American Jaguar

Felis centralis Mearns, Proc. Biol. Soc. Washington, vol. 14, p. 139, Aug. 9, 1901. Type No. 14177, [♂] adult, skull only, U. S. National Museum, collected by W. M. Gabb.

Felis onca centralis Goldman, Smiths., Misc. Coll., vol. 69, no. 5, p. 166, 1920.

Type locality.—Talamanca, Costa Rica (probably near Sipurio, in the valley of the Rio Sicsola).

Distribution.—Central America north to Salvador and along the Pacific coast probably to near the Isthmus of Tehuantepec; south to Guaduas, Cundinamarca, Colombia.

General characters.—A rather small form, closely resembling *hernandesii* but apparently averaging slightly darker; ground color of upper parts cinnamon buff instead of light ochraceous buff, the prevailing tone in the latter; black rosette rings considerably broken; skull very similar to that of *hernandesii*, but nasals less depressed anteriorly, more highly arched as viewed from the front. Similar in color to *major*, but skull smaller with decidedly lighter dentition and more strongly developed lambdoid crest. Differing from *goldmani* mainly in decidedly larger size.

Measurements.—No external measurements in the flesh available. *Skull* (see table, p. 232).

Remarks.—The close agreement of *centralis* and *hernandesii* in general characters is rather remarkable, in view of their geographically widely separated ranges.

Some specimens of both forms are practically indistinguishable but the combination of slight characters pointed out is usually distinctive.

Specimens examined.—Total number, 10, as follows:

COLOMBIA: Guaduas, Cundinamarca, 1 (skull only).

COSTA RICA: Pozo Azul, 1 (skull only); without definite locality, 1 (skull only).

NICARAGUA: Province of Zelaya, 1 (skull only); San Rafael del Norte, 1.[9]

PANAMA: Atlantic side, 1 (skull only);[10] Boca de Cupe, 1;[9] Rio Peluca, 1 (skull only);[10] Tapalisa, 1.[9]

SALVADOR: Conchagua Volcano, La Union, 1 (skull only).

Felis onca goldmani Mearns

Yucatan Peninsula Jaguar

Felis hernandesii goldmani Mearns, Proc. Biol. Soc. Washington, vol. 14, p. 142, Aug. 9, 1901. Type No. 105930, skin only, U. S. National Museum, collected by E. A. Goldman, Jan. 5, 1901.

Felis onca goldmani Goldman, Proc. Biol. Soc. Washington, vol. 45, p. 144, Sept. 9, 1932.

Type locality.—Yohaltun, Campeche, Mexico.

Distribution.—The peninsula of Yucatan, south to northern Guatemala and probably British Honduras.

General characters.—Size smallest of the jaguars. Black markings small, in keeping with diminutive body dimensions. Most closely resembling *centralis*, but smaller; ground color of upper parts about the same in cinnamon buffy tone, and rosettes similarly broken; skull smaller, less angular, the sagittal and lambdoid crests less developed.

Measurements.—No external measurements in the flesh available. *Skull* (see table, p. 232).

Remarks.—The diminutive size of this jaguar at once distinguishes it from all of the other subspecies. It presents a remarkable contrast with the large jaguar of Vera Cruz, described beyond, although there is only a short distance between the ranges of the two, and intergradation may confidently be assumed.

Specimens examined.—Total number, 10, as follows:

CAMPECHE: La Tuxpeña, Champoton, 3 (2 skulls only, 1 skin only); Yohaltun, 1 (type—skin only).

GUATEMALA: Laguna El Sotz, Peten, 2 (skulls only); Lake Peten, 2 (skulls only); La Libertad, 1; Remote, Peten, 1 (skull only).

Felis onca hernandesii (Gray)

West Mexican Jaguar

Leopardus hernandesii Gray, Proc. Zool. Soc. London, 1857, p. 278, pl. 58. Described from an individual in the Gardens of the Zoological Society of London.

Felis hernandesii Mearns, Proc. Biol. Soc. Washington, vol. 14, p. 141, Aug. 9, 1901.

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[9] Coll. Amer. Mus. Nat. Hist.

[10] Coll. Mus. Comp. Zool.

Felis onca hernandesii Goldman, Proc. Biol. Soc. Washington, vol. 45, p. 144, Sept. 9, 1932.

Type locality.—Mazatlan, Sinaloa, Mexico.

Distribution.—Western Mexico from Sinaloa south to the Isthmus of Tehuantepec.

General characters.—A rather small subspecies, closely resembling *centralis*, but apparently averaging slightly paler, the ground color of upper parts variable but near light ochraceous buff, instead of cinnamon buff; black rings of rosettes usually rather small and considerably broken, the number of small enclosed spots varying to as many as nine; skull very similar to that of *centralis*, but nasals more depressed anteriorly, less highly arched as viewed from the front. Approaching *arizonensis* in color and depressed condition of nasals, but smaller and the nasal character less extreme in development; interpterygoid fossa opening more widely, the lateral margins usually less strongly turned inward. Differing from *goldmani* in decidedly larger size, and in about the same cranial details as from *centralis*.

Remarks.—The range of *hernandesii* is separated from that of the jaguar of eastern Mexico, described later, by the southward thrust of the central highlands that form an effective, wedge-shaped barrier broadly separating the two northern forms of the species. The extensively broken rings of the rosettes, described and depicted by Gray and varying widely in all forms, seem to be fairly constant as an average character.

Specimens examined.—Total number, 16, as follows:

COLIMA: Coast Range (below Colima City), 1 (skull only);[11] Colima, 1 (skull only).

GUERRERO: Acapulco, 1 (skull only), 3 (skins only); Papayo, 1.

NAYARIT: San Blas, 1 (skull only).

OAXACA: Chivela, 1 (skull only); Tehuantepec, 2 (skulls only).

SINALOA: Agua Brava, 1;[11] Escuinapa (about 40 miles south of type locality and regarded as typical), 4.[11]

Felis onca veraecrucis, subsp. nov.

Northeastern Jaguar

Type.—From San Andres Tuxtla, Vera Cruz, Mexico. No. 67403, ♂ adult, skull only, U. S. National Museum (Biological Survey collection), collected by Nelson and Goldman, April 24, 1894. Original number 6090.

Distribution.—Gulf slope of eastern and southeastern Mexico from the coast region of Tabasco north through Vera Cruz and Tamaulipas to central Texas.

General characters.—Size largest of the North American subspecies. Color about as in the other North American forms but rosettes rather large; skull differing in size and combination of details.

Color.—Female from Perez, Vera Cruz: Ground color of upper parts in general pale cinnamon buff, slightly darker within the black rings of the rosettes as usual in the species, and paling gradually to light ochraceous buff on cheeks, sides of neck, flanks, and outer surfaces of legs; black spots and crescentic black rings of

[11] Coll. Amer. Mus. Nat. Hist.

rosettes enclosing small black spots rather large and heavy; black spots irregularly confluent along median line on posterior part of back; under parts and inner surface of legs white, heavily spotted with black; outer sides of ears black with cinnamon buff central spots; tail with large irregular black markings, separated by narrow, light interspaces buffy on basal half above, becoming white toward ip and below. A specimen from between Aldama and Soto la Marina, Tamaulipas, is similarly marked, but the ground color is slightly lighter in tone. One from Goldthwaite, Texas, is somewhat paler, the rosettes are larger, the black rings are more broken, and the posterior median dorsal spots are irregularly paired instead of confluent.

Skull.—Somewhat larger and more elongated than that of *F. o. arizonensis*, anterior nares much higher, the nasals more highly arched, less depressed anteriorly; interpterygoid fossa wider, the lateral margins less strongly turned inward; audital bullae usually larger; dentition similar but canines usually larger. Similar to that of *hernandesii* but decidedly larger, more massive; anterior nares higher, the nasals more highly arched anteriorly; canines larger. Differing from those of *goldmani* and *centralis* mainly in much larger size, the contrast greatest with *goldmani*.

Measurements.—An adult male and female, respectively, from between Aldama and Soto la Marina, Tamaulipas: Total length, 1,993, 1,574 mm.; tail vertebrae, 533, 432. *Skull* (see table, p. 232).

Remarks.—The northeastern jaguar is probably more closely allied to *centralis* than to any of the other subspecies. In view of the geographic nearness of the small form, *goldmani*, which inhabits the Yucatan Peninsula, the disparity in size is remarkable; but intergradation of the two may safely be assumed.

Specimens examined.—Total number, 8, as follows:

CHIAPAS: Palenque, 1 (skull only).

TABASCO: Frontera, 1 (skull only).[12]

TAMAULIPAS: Between Aldama and Soto la Marina, 2 (1 skull only).[13]

VERA CRUZ: Orizaba, 1 (skull only);[14] Perez, 1; San Andres Tuxtla (type locality), 1 (skull only).

TEXAS: Goldthwaite, Mills County, 1.

Felis onca arizonensis Goldman

Arizona Jaguar

Felis onca arizonensis Goldman, Proc. Biol. Soc. Washington, vol. 45, p. 144, Sept. 9, 1932. Type No. 244507, ♂ adult, skin and skull, U. S. National Museum (Biological Survey collection), collected by Jack Funk, April 12, 1924.

Distribution.—Mountainous parts of eastern Arizona north to the Grand Canyon, southern half of western New Mexico, and northeastern Sonora.

General characters.—A large northern subspecies, distinguished from all the other races by the flatter, more depressed nasals. Most closely allied to *hernan-*

[12] Collection Amer. Mus. Nat. Hist.

[13] Collection Carnegie Mus.

[14] Collection Mus. Comp. Zool.

desii, general colors and markings much the same, but size larger and cranial characters distinctive; skull more massive; rostrum broader; nasals much flatter, more depressed anteriorly; anterior nares wider but not as high; interpterygoid fossa opening narrower.

Measurements.—Type (tanned skin): Total length, 2145; tail, 660; hind foot, 230. *Skull* (see table, p. 232).

Remarks.—F. o. arizonensis reaches the extreme northern limit of the range of the species at the present time. Formerly it reached, according to the records, to southeastern California. While not very abundant it appears to be a regular resident of southeastern Arizona.

Specimens examined.—Total number, 5, as follows:

ARIZONA: Cibecue (type locality), 1; Greaterville, 2; Nogales (20 miles west), 1 (skull only).

SONORA: West foothills of Sierra Madre, due west of Casas Grandes, Chihuaha, 1 (skull only).

INAPPLICABLE OR UNIDENTIFIABLE NAMES

The nomenclature of the cats is much involved, many names being so vaguely used, or the accompanying descriptions being so inadequate that correct application is very uncertain if not impossible. The following list is believed to include the more important names requiring consideration in relation to the jaguar, but which for various reasons are not regarded as assignable to any particular form. No attempt is made to complete the synonymy which would be voluminous.

A. NAMES PROPOSED BY NON-BINOMIAL AUTHORS

1756. *Tigris americana* Brisson, Règne Anim., 1756, p. 270.
Pre-Linnaean use of this name for the jaguar, based on the accounts of earlier authors. Habitat in America.

1756. *Tigris nigra* Brisson, Règne Anim., 1756, p. 271.
Applied to the black phase of the jaguar in Guiana and Brazil.

1762. *Tigris americana* Brisson, Regnum Anim., 1762, p. 196.
Name repeated from his Règne Animal, 1756, p. 270, for the jaguar. Habitat in America.

1762. *Tigris nigra* Brisson, Regnum Anim., 1762, p. 196.
Name repeated from his Règne Animal, 1756, p. 271 for the black phase of the jaguar in Guiana and Brazil.

1769. *Tigris americana* Fermin, Descrip. Gén., Hist., Géog. et Phys. Colon. de Surinam, vol. 2, p. 97, 1769.
Vaguely used in referring to several kinds of spotted cats said to be widely distributed in America and found in Surinam. The jaguar probably was included in the general discussion, but binomial names are not consistently used by the author, and the name is regarded as unidentifiable. Fermin gives no references, but the name had been used by pre-Linnaean authors (Brisson, Règne Anim., 1756, p. 270, and others) for the jaguar of Brazil and the general range of the animal.

B. NAMES PROPOSED BY BINOMIAL AUTHORS

1775. *Felis panthera* Schreber, Die Säug., pl. 99, 1775; text, theil 3, p. 384, 1777.
The name *F. panthera*, is somewhat involved. In Schreber's work the name appears only on the plate as "Felis Panthera Buff" which is a repro-

duction of the "La Panthère Femelle" of Buffon (Hist. Nat., vol. 9, pl. 12, 1761). Buffon's plate is of an individual that had been kept a long time in the menagerie of Versailles. Buffon, p. 151 (op. cit.) assigns the animal to the Old World, but the drawing, showing enclosed spots in a number of the rosettes, suggests a jaguar. The tail, however, is too long and like that of a leopard. In describing the markings on the sides of the body Buffon says there is a small black spot in the center of the "pluspart de ces anneaux." While enclosed spots are much more characteristic in the jaguar they are sometimes present in a few of the rosettes on the leopard. The measurements of Buffon's "panthère femelle" indicate a proportional length of tail about as in the jaguar. Buffon evidently was not familiar with the jaguar and his illustration of the animal (plate 18, op. cit.) almost certainly represents an ocelot, as shown by the nuchal stripes, body markings and general proportions, including length of tail. His "Jaguar de la Nouvelle Espagne," described 15 years later (Hist. Nat., Suppl., vol. 3, p. 218, pl. 39, 1776), appears also to have been an ocelot. *Felis panthera* Schreber was, therefore, based upon a confused concept. The bulk of the somewhat conflicting evidence seems to favor reference of the name to the general synonymy of *Felis onca* rather than to that of *F. pardus* of the Old World.

1777. *Felis nigra* Erxleben, Syst. Regni Anim., 1777, p. 512.

Based upon *Tigris nigra* Brisson (Règne Anim., 1756, p. 271) and the black jaguar of other authors. Habitat given as Brazil and Guiana. Evidently refers to the black or melanistic phase of the jaguar, although Erxleben remarked that he was inclined to believe it represented a dark variety of *Felis concolor*.

1777. *Felis discolor* Schreber, Die Säug., theil 3, p. 393, pl. 104 B, 1777.

The name appears only on the plate. The text refers to the "black Tiger" of Pennant (Syn. Quad., 1771, p. 180, pl. 18, fig. 2). Comparison of Schreber's plate with that of Pennant shows that the former was redrawn from the latter. Pennant assigned the animal to a habitat in Brazil and Guiana. This is one of the names used for the black phase of the jaguar, without definite locality.

1795. *Felis jaguar* Link, Beyträge Zur Naturgesch., Zweytes stuck, p. 90, 1795.

A renaming of *Felis onca*. *Felis jaguar* was used by Temminck (Monog. Mamm., vol. 1, 1827, pp. 136, 256) as a common appellation in French for *Felis onca*, and was listed by Elliot (Monog. Felidae, 1883, p. unnumbered) in the synonymy of the species.

1816. *P[anthera] americana* Oken, Lehrb. der Naturgesch., theil 3, abt. 2, 1816, pp. 1054, 1061.

The jaguar is here involved in the use of the name but the description and references are very loosely drawn. The name is antedated by *Tigris americana* Brisson, 1762, and preoccupied by *Tigris americana* Fermin, 1769.

1816. *P[anthera] mexicana* Oken, Lehrb. der Naturgesch., theil 3, abt. 2, 1816, p. 1054.

Under this name Oken listed the "Tlaco-Ozelotl, Tlal-Ocelotl, Catus-Pardus mexicanus, *Panthera americana*" and "*F. pardalis*." Apparently associated with the last mentioned he says "Die alten Könige von Mexico

hatten dieses Thier um den Thron liegen." The next paragraph under the same heading, however, begins with "Jaguar (ist Tlaco-Ocelotl)." Aside from this confused application the name is preoccupied by *Felis mexicana* Desmarest (Nouv. Dict., vol. 6, p. 112, 1816 edition [original date of publication about Feb. 4, 1803—see Osgood, Proc. Biol. Soc. Washington, vol. 27, p. 3, Feb. 2, 1914]) which was based upon the "Chat Sauvage de la Nouvelle Espagne" of Buffon (Hist. Nat., Suppl., vol. 3, p. 227, pl. 43, 1776). Buffon himself (l.c. p. 228) regarded this as the same as the Serval, described and figured in his earlier work (Hist. Nat., vol. 13, p. 236, pl. 34, 1765).

1830. [*Felis onca*] *minor* Fischer, Syn. Mamm., Addenda, 1830, p. 366 (= p. 566).

Based on "The Jaguar. Small or common var. *F. onca*, L." of Hamilton Smith (Griffith, in Cuvier's Anim. King., vol. 2, p. 456 and colored text fig., 1827). No locality was given and the name is unidentifiable (See remarks under *Felis onca major*, p. 233).

1841. *Felis onca nigra* Wagner, in Schreber's Säug., Suppl., band 2, abth., 2, 1841, p. 475.

Reference under *Felis onca* to *Felis nigra* Erxleben.

1869. *Panthera onca minor* Fitzinger, Sitzungsber. Math.-Naturwissensch. Cl. Kais. Akad. Wissensch., band 59, abth. 2, p. 216, 1869.

Obviously equal to *Felis onca minor* Fischer (1830) to which reference is made by Fitzinger. The name is here ascribed to the animal of Mexico and the southern part of the United States, but is inapplicable as it was based upon an unidentifiable form.

1869. *Panthera onca alba* Fitzinger, Sitzungsber. Math.-Naturwissensch. Cl. Kais. Akad. Wissensch., band 59, abth. 2, p. 218, 1869.

Applied to an apparently albinistic color phase of the jaguar in Paraguay and in "Peru oder in Venezuela." Preoccupied by *Felis alba* Fischer (Syn. Mamm., Addenda, 1830, p. 366 [= 566]), based on the "white Tiger" of Griffith (Cuvier's Anim. King., vol. 2, p. 444 and text fig., 1827).

1869. *Felis onca poliopardus* Fitzinger, Sitzungsber. Math.-Naturwissensch, Cl. Kais. Akad. Wissensch., band 59, abth. 2, p. 220, 1869.

Name first proposed as *Felis poliopardus* Fitzinger (op. cit. band 17, pp. 295–297, 1 pl., 1855). Regarded by Fitzinger as a hybrid between *Felis onca* of Brazil and *Felis pardus* of west Africa.

1872. *Felis jaguarete* Liais and *Felis jaguapara* Liais, Clim. Géol., Faune du Brésil, 1872, p. 451.

In protest against the use of the name onça, introduced in Brazil by the Portuguese colonists, for an American animal, Liais proposed that *Felis onca* be transferred to the Asiatic species bearing the name *Felis uncia* which he ridiculed. Accepting the belief of some authors in the existence of two distinct species and having thus disposed of *F. onca* he proceeded to name the "grand jaguar" *Felis jaguareté* and the "petit" *Felis jaguapara*. By inference both of these are from Brazil, but without definite localities and are therefore unidentifiable.

1872. *Felis jagualyrica* Liais, Clim. Géol. Faune du Brésil, 1872, p. 459.

Name proposed for a form of the black jaguar of Brazil.

U. S. Biological Survey, Washington, D. C.

THE IMPORTANCE OF TYPES AND TYPE LOCALITIES

By Vernon Bailey

Early naturalists paid little attention to types of species or to exact localities from which they originated, and in many cases confusion in the study of species has resulted from this lack of a definite starting point. Now the designation of a type specimen, type locality, and date of collection are considered essential in the description of any new form, and their omission would subject the author to well-merited criticism. There are many names today that cannot be used because the authors neglected to give the information necessary to fix them unmistakably to definite species.

Forty-six years ago, when I began field work for the Biological Survey, Doctor Merriam's first letter of instructions directed me to get specimens of a little pocket mouse, *Perognathus fasciatus*, and the grasshopper mouse, *Onychomys leucogaster*, both collected in 1833 by Maximilian, Prince of Wied, at Old Fort Union, near the present town of Buford, North Dakota. The types of these species were somewhere in Germany, and few other specimens had ever been collected. I secured specimens of both, and as each was the type of its genus, they were important in all later work on the groups, especially when Osgood, in 1900, monographed the pocket mice (North American Fauna No. 18), and Hollister, in 1914, the grasshopper mice (Proc. U. S. Nat. Mus., vol. 47).

Since then I have been to so many type localities of mammals that even a list of them would be tiresome, but enough has been said to show that much of the accuracy and stability of our present knowledge of specific characters and ranges of the various species and subspecies of North American mammals depends upon adequate series of specimens from the type localities. In many cases the type specimen, important as it is, is less so than a good series of specimens, or topotypes, from the same place that show the range of invidual variation, and variation due to age, season, and other modifying causes. Any museum where topotypes of mammals, birds, fish, reptiles, or other groups are well represented is a good place to study groups of these classes or collections of specimens from a locality or region, and requests received by museum curators for the loan of study material generally call for series of typical specimens.

The search for topotypes that Doctor Merriam started in 1887 has brought out many interesting developments and has led to the correction of many errors. In 1895 I was sent to the Bitterroot Valley, Montana,

to collect topotypes of a pocket mouse described by Baird in 1857 as *Perognathus monticola*. The type and only specimen was sent to the National Museum in 1864, by Father Ravilla from St. Mary's Mission, Montana, where it was supposed to have been collected. I wasted a week trying to find pocket mice around the site of the ruins of the old mission at Stevensville, and all up and down the Bitterroot Valley, and proved as well as could be proven by negative evidence that no such animal inhabited the valley. Undoubtedly the specimen was brought from Oregon, as Osgood later identified it with *Perognathus parvus* from The Dalles, Oregon, and placed it under that older name as a synonym. Thus a difficult situation in nomenclature was cleared up, but if the locality from which the specimen actually came had been given *monticola* would not have been described and added to synonymy.

Another published error that gave mammalogists trouble for nearly a century was the erroneous location of the type locality of a pocket gopher, *Thomomys townsendii*. The specimen was collected by J. K. Townsend in 1834 and sent to the Philadelphia Academy of Sciences without a label. Doctor Bachman, when he named it, gave its locality as the Hudson's Bay trading post on the Columbia River, from which place it had been shipped with other specimens around the Horn to Philadelphia. At different times Clark P. Streator, J. Alden Loring, and I trapped about the site of the old post in vain, getting only the common *Thomomys douglasii* there. Finally, when, monographing the genus *Thomomys*, I asked Doctor Witmer Stone's permission to remove the skull from Bachman's type, and at once recognized it as a species I had recently described from western Idaho. Then, tracing Townsend's journey across the country I located the actual place where he had collected the gopher near the type locality of my *Thomomys atrogriseus* at Nampa, Idaho. It was a great satisfaction to clear up this old name though it placed my own species in synonymy.

In my recent trip across Mexico with Frederick Winthrop, we collected a small series of big yellow fox squirrels on the Bavispe River, in northern Sonora, at the type locality of *Sciurus apache*. As only the type and one other specimen were available before from this region, our series showed the range of variation in characters and enabled E. A. Goldman to recognize a well marked species that he had collected in the Chiricahua Mountains, Arizona, several years ago, but dared not risk naming until more typical material was obtained.

On this same trip across northern Mexico we collected topotypes of a number of species of mammals and other specimens that will eventually

help to settle doubtful points in nomenclature. Two very old names for the opossum, *Didelphis mesamericana* Oken, 1816, and *Didelphis californica* Bennett, 1833, are both ascribed to that part of Mexico adjacent to California. A flat skin of an opossum secured at a ranch near Oputo in the Bavispe River Valley, and reports of occasional occurrence of the animals near Llano, extend their known range much nearer to California than previously supposed, and if future field work shows, as it doubtless will, that they follow down the Magdalena and Asuncion Rivers to near the head of the Gulf of California, the work of settling the status of these old names will be much simplified.

Hundreds of specific cases could be cited to show how series of specimens of mammals from type localities have cleared up doubtful nomenclature or established specific characters, and every field naturalist, as well as museum worker, knows the value of such collections. While there is still much to be done along these lines there is a great satisfaction in what has been already accomplished by the many field collectors under wise direction.

U. S. Biological Survey, Washington, D. C.

A NEW FORM OF MICROMYS FROM HONDO, JAPAN

By Nagamichi Kuroda

Micromys minutus hondonis, subsp. nov.

1931. *Micromys minutus japonicus* (nec Thomas), Kuroda, "Amoeba," vol. 3, no. 3, p. 15, pl. 2.

Type.—Adult female (N. Kuroda coll. no. 1391); Kashiya, Kannami-mura, Tagatagori, Prov. Izu, Hondo; collected August 19, 1931, and died July 22, 1932; N. Kuroda collector.

Characters.—Resembles *Micromys minutus japonicus* from Shikoku and Kiusiu; but the length of tail very much longer than the length of head and body (instead of the tail shorter than head and body as in *japonicus*); hind foot longer, 16–16.5 mm., instead of 14.5–15 mm. as in *japonicus*; ear also longer, 9.5–12 mm., instead of 7 mm. as in *japonicus*; and the white hairs of ventral surface have no slaty bases. It also differs from *M. minutus aokii* Kuroda (Journal of Mammalogy, vol. 3, no. 1, 1922, p. 43) from the island of Tsushima, in having the hind foot and ear longer; the coloration much darker on back, even in the summer pelage; the point of demarkation of dorsal and ventral surfaces has no distinct fox-red line as in *aokii*, but this line is replaced by an indistinct paler and buffy line.

Skull.—Larger and broader than that of *japonicus* and *aokii*; the greatest length more than 20 mm. instead of less than 20 mm.; the breadth of braincase reaching to 9.5 mm.; palatilar length also longer.

Description (summer pelage).—Length of tail 16 mm. longer than the length of head and body (in young ones it is 5–10 mm. longer than the latter); dorsal parts sepia brown, more or less mixed with rufous hairs; lower rump and base of tail rufous; border of dorsal and ventral parts rather well defined, the sides of body paler and more buffy than rump; ear covered with buffy or sepia brown hairs; hands and feet covered with silvery buffy white hairs; tail very long and uniform dark colored with short whitish hairs; ventral parts of body pure white, hairs without any slaty color at base. In winter and juvenile pelage the dorsal parts change to much darker sepia brown than in the summer pelage just described.

Measurements in millimeters

No.	*Sex*	*Head and body*	*Tail*	*Hind foot*	*Ear*
1389	♀ sub-ad.	66.5	76	16	9.5
1390	♂ sub-ad.	68	73	16	10
1391 (type)	♀ ad.	75	91	16.5	12
1392	♀ sub-ad.	66	82	16	9.5

Skull measurements (type).—Greatest length, 21 mm.; basilar length, 16.5; zygomatic breadth, 10; length of nasals, 7; interorbital breadth, 3.5; breadth of braincase, 9.5; diastema, 5.1; palatilar length, 9; foramen incisivum, 4; length of upper molar series, 3.1; breadth of m^1, 1.

Distribution.—This form inhabits the Provinces of Izu and Suruga, and the same form seems to be found near Ikegami in the Province of Musashi and at Shinhama in the Province of Shimosa, all on the Pacific side of Hondo.

Fukuyoshi Cho, Akasaka, Tokyo, Japan.

NEW PLIOCENE REMAINS OF DIPROTODONT MARSUPIALS FROM ARGENTINA

By Carlos Rusconi

The genus and species *Argyrolagus palmeri* were founded by Florentino Ameghino in 1904 on a mandibular fragment lacking the condyle and most of the coronoid process. This fragment was illustrated for the first time in Ameghino's work published in 1906 (p. 368, fig. 221).

This jaw was found in the Hermosense beds at Monte Hermoso, some 60 leagues south of Mar del Plata, by Carlos Ameghino. When the latter found and examined this fragment, he realized its great importance, and wrote to his brother Florentino, that he had found a mandibular fragment belonging to the group of the "plagiaulacoids" somewhat re-

lated to the marsupials of Patagonia, but the molars of which had open bases.[1]

After studying this fragment, F. Ameghino decided to publish the results of his observations and, in so doing, he advanced the thesis that the mandible of the *Argyrolagus* belonged to a duplicidentate rodent, the ancestor of all the known lagomorphs. He based this idea on the fact that its first incisor was arched and resembled those of the rodents, and that behind this tooth lay an alveolus which he considered as belonging to a second incisor.

After this date nobody studied the mentioned fossil,[2] until a reëxamination, and the discovery of other similar animals, allowed the late Professor Lucas Kraglievich to advance the idea that *Argyrolagus palmeri* was not a rodent, as F. Ameghino supposed, but a true marsupial, more closely related to some diprotodont marsupials than to the paucituberculates that lived during the lower Tertiary of Patagonia.

Kraglievich's thesis was based on certain important details, such as the construction of the base of the ascending branch of the mandible, a small hole situated at the bottom of the masseteric depression, and also because the general aspect was more like that of a marsupial than that of a duplicidentate rodent.

Mr. Lorenzo J. Parodi[3] on a recent trip to the town of Miramar, had the luck of disinterring from the typical Chapadmalense beds a mandibular fragment of an argyrolag. This specimen included the two last molars, together with the ascending ramus and the condyle. This hinder part of the mandible was hitherto completely unknown. The new fragment represents a new species, which I propose to name after the discoverer of the type specimen:

Argyrolagus parodii, new species

Type.—Posterior part of the mandible with the two last molars. Parodi collection.

Type locality.—Miramar, province of Buenos Aires; *Chapadmalense* beds, Middle Pliocene.

Ascending ramus lower than that of *Argyrolagus palmeri*, but somewhat larger

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[1] This written communication will appear at the end of the complete work of Dr. Florentino Ameghino.

[2] In his work of 1914, Rovereto makes no important observation about *A. palmeri*.

[3] I thank this friend for his kindness in allowing me to study this important fragment.

than that of the *A. catamarcensis* Kragl. Though the coronoid crest in the type specimen is rather deteriorated it rises above the level of the occlusal surface of the hinder molars.

Between m_3 and the coronoid crest there is an excavated surface that is placed in an oblique direction and in whose bottom there is a vertically descending hole that communicates with the posterior dental foramen (fig. 1 *a*). This canal apparently does not exist in *A. palmeri*. A similar canal is not known in some macropodids and in several genera of didelphids. It does exist in certain paucituberculate marsupials, as for instance *Abderites crassiramis* Amegh., of the Santa Cruzean, and *Parabderites bicrispatus* Amegh. of the Trelewense beds (Colpodonense) of Patagonia, both illustrated by Ameghino in his work of 1903 (p. 121, fig. 39, and p. 123, fig. 43).

The anterior margin of the coronoid crest of *A. palmeri* is inclined obliquely downward. It describes a feeble curve and terminates at the level of the penulti-

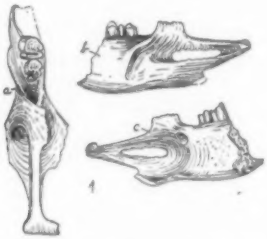


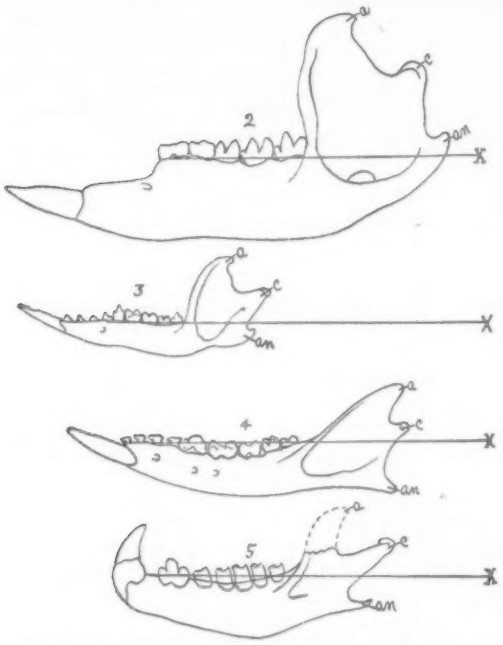
FIG. 1. INCOMPLETE MANDIBLE OF ARGYROLAGUS PARODII, NEW SPECIES
a, superior view; *b*, external view; *c*, internal view. ×2

mate molar. The corresponding margin of *A. parodii*, on the contrary, ends in a strong bony edge, bent downward nearly at a right angle, and behind it there appears an irregular and rather characteristic depression. Immediately behind this depression and about half way between the upper and lower margins of the mandible, the inferior margin of the masseteric depression takes its origin; this depression is wing-shaped, its edge is sharp, and it terminates on the outer side of the condyle (fig. 1 *b*). On this crest we find the depression that I have mentioned. It is narrow in the vertical sense, but long in the horizontal sense. In its bottom there is a perforation or abrasion about 5 mm. long, partly produced by accident. The anterior margin of this perforation is, however, intact. This makes us believe that an aperture naturally existed there, through which the soft parts penetrated and communicated with the posterior dental foramen.

On the inner side, the mandible (fig. 1 *c*) has a bony wing; which doubtless represents an angular process similar to that of many marsupials. Its surface is laminated. It is so oriented as to form an angle of nearly 45 degrees with the vertical plane of the horizontal ramus, more or less as Kraglievich describes in *A. palmeri*. On this crest, the great pterygoid depression is situated, and in its

bottom and anterosuperior angle is situated the posterior dental foramen, as is the case with the fragment collected at Monte Hermoso.

But what was unknown up to now, is, as I have already mentioned, the construction and backward prolongation of the mandibular condyle, a condition that

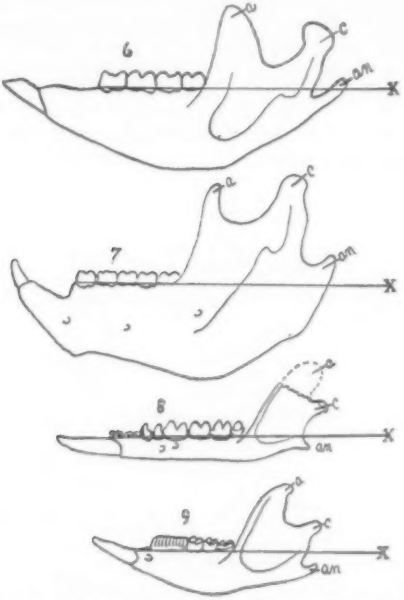


FIGS. 2–5. EXTERNAL VIEWS OF LEFT MANDIBLES

a, coronoid process; *an*, angular process; *c*, condylar process; *x*, alveolar line. Fig. 2, *Macropus* sp.; fig. 3, *Caenolestes obscurus* Thos.; fig. 4, *Paraepanorthus minutus* Ameghino; fig. 5, *Necrolestes patagonicus* Ameghino. Varying scale of reduction.

I have not been able to find a suggestion of in many marsupials and insectivores. Guiding himself by the plane of the fracture and the orientation of the coronoid process, Kraglievich supposed that the mandibular condyle of *Argyrolagus palmeri* was elevated in its position, but judging by the new specimen, we see that the position of the condyle differs fundamentally from that of numerous diprotodont marsupials, paucituberculates, and even some extinct insectivores. Thus, for example, in *Macropus* sp. (fig. 2); *Caenolestes obscurus* Thos. (fig. 3); *Paraepanor-*

thus minutus Amegh. (fig. 4); *Necrolestes patagonicus* Amegh. (fig. 5); *Phascolomys ursinus* (Shaw) (fig. 6); *Phascolarctus cinereus* (fig. 7); *Stylotherium dissimile* Amegh. (fig. 8); *Bettongia lesueuri* (fig. 9), the mandibular condyle rises notably above the level of a line drawn between the first and the last dental alveolus, while in *Argyrolagus* (fig. 10), and in *Taeniolabis taõensis* Cope (= *Polymastodon taõensis*) the condyle, on the contrary, lies below this level.



FIGS. 6-9. EXTERNAL VIEWS OF LEFT MANDIBLES

Fig. 6, *Phascolomys ursinus* (Shaw); fig. 7, *Phascolarctus cinereus;* fig. 8, *Stylotherium dissimile* Ameghino; fig. 9, *Bettongia lesueuri*. (For explanation of abbreviations, see figs. 2–5.)

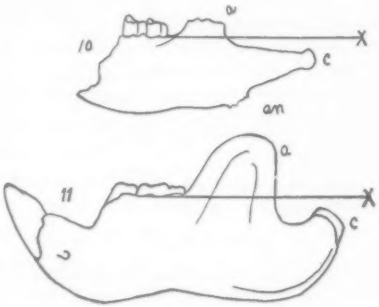
Another important detail is that the articular process of *Argyrolagus parodii* is prolonged backwards extraordinarily behind the last molar and is tapered gradually toward the condyle, somewhat as in the interesting insectivore of the lower Tertiary of Patagonia, *Necrolestes patagonicus* (fig. 5).

The condyle of the macropodids is flat transversely and convex antero-posteriorly; it has the shape of a small bony head. That of *Argyrolagus parodii* is concave transversely and slightly convex antero-posteriorly, with the further peculiarity that it is noticeably built out on the side directed toward the basicranial region.

The extraordinary distance between the condyle and the hinder edge of the

last molar, and the remarkably low position of the articular surface relatively to the alveolar margin are, in my opinion, primitive characters. I also believe that the elements of this region are less highly evolved than they are in the marsupials and other mammals that I have mentioned above. From this peculiar construction I further deduce that the glenoid cavity of the *Argyrolagus* skull, in order to be able to articulate with the head of the mandibular condyle, must have been very much prolonged, so that it probably extended beyond the horizontal level of the triturating surface of the superior molars.

The inferior mandibular edge in the new species, principally from the level of the penultimate molar backwards, is straighter than it is in *A. palmeri*. There is some difference between the two hinder lower molars, but the most important is the slightly greater thickness of m_3 as compared with the penultimate molar. In *A. palmeri* these teeth are of nearly equal size.



FIGS. 10–11. EXTERNAL VIEWS OF LEFT MANDIBLES

Fig. 10, *Argyrolagus parodii*, new species; fig. 11, *Taeniolabis taöensis* Cope. (For explanation of abbreviations, see figs. 2–5.)

CONCLUSION

Kraglievich said that *Argyrolagus*, with its rootless molars, belonged to a group of marsupials much more specialized than others that lived in Patagonia during the middle and lower Tertiary; he consequently did not admit that any of these others could be its precursor.

Argyrolagus parodii clearly reveals that the construction and the position of the mandibular condyle, which is placed at a lower level than the dental series, approaches that of mammals of general archaic organization; although judged by its teeth alone, *Argyrolagus* would represent a faunal element of high specialization through the loss of the dental roots. Granting that the ancestry of the argyrolags can be traced successfully in this manner, it is less easy to determine the center of their origin. The paucituberculated marsupials of Patagonia represent a group of mammals that evolved in a different way; and, according to present knowledge, there is no probability of the existence of a link between them and the *Argyrolagus* group. Neither is there any valid evidence that these Pliocene marsupials of Argentina might have come from the Australian region.

Therefore it would not be strange if Kraglievich's theory was proved true some day. According to it, the original home of the argyrolags would have been in a "*terra incognita*," possibly in a South Pacific continent, where the primordial phalangerids could have existed before they irradiated and went partly to Australia and partly to South America. But in that case it is obvious that we must admit a connection of that South Pacific continent with the central and northwestern part of Argentina through Chile (excluding Patagonia) during the Miocene, as furnishing the way by which *Argyrolagus* could have come in (p. 254).

This opinion seems to me the best, and I could only modify it with better elements of judgment than those I dispose of now. For the translation in English I express my gratefulness to Miss Violeta Lelong.

Mandibular measurements (in millimeters)

	Argyrolagus parodii, n. sp.	*A. palmeri*
Length of the mandibular fragment	19	22
Vertical diameter of horizontal ramus	5	7
Transverse diameter of horizontal ramus	2.3	2.4
Distance from posterior margin of last molar to condyle	12	
Transverse breadth of condyle	3	
Height of horizontal ramus behind last molar	5.5	
Anteroposterior diameter of m_2	1.9	
Anteroposterior diameter of m_3	1.3	
Space occupied by the two last molars	3	

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Garay 3818, Buenos Aires, Argentina.

NEW FELIDS FROM THE UPPER PLIOCENE OF IDAHO

By C. Lewis Gazin

During a study of the equid material from the *Plesippus* Quarry in southern Idaho I have found in the Smithsonian collections from the quarry and from beds in the immediate vicinity a variety of interesting mammalian types. Particularly noteworthy are the remains of carnivora. This material consists of jaws, teeth and limb fragments representing two distinct felids, a canid and several mustelids.

For the purpose of this study the California Institute of Technology, through the kindness of Dr. Chester Stock, has loaned felid material obtained by its field parties in deposits presumably of late Pliocene age in the vicinity of Grand View, Idaho. The Smithsonian collections are from near Hagerman, Idaho, where a late Pliocene age for the beds seems established by the occurrence of *Plesippus shoshonensis* Gidley.[1]

A previous record of the occurrence of felid remains in deposits exposed in the Snake River basin is that of *Ischyrosmilus idahoensis* Merriam.[2] The lower jaw of this large sabre-tooth cat was found near Froman's Ferry in beds that may be comparable in age to those at Hagerman, or possibly somewhat younger. The new felids recognized in the present paper are a true cat apparently of the puma-type and what appears to be a small sabre-tooth form presumably representing the genus *Machairodus*.

Felis lacustris, new species

Type.—Right ramus of mandible, No. 12611 U. S. N. M., with canine and cheek-teeth.

Locality.—T. 7 S., R. 13 E., near Hagerman, Idaho.

Horizon.—Hagerman lake beds.

Specific characters.—Size of mandible smaller than average of *Felis concolor*. Symphysis shallow, with rounded anterior margin not projecting downward so markedly as in *F. concolor*. Canine short and robust. Cheek-teeth slender with premolars relatively narrower anteriorly and carnassial small.

Material.—In addition to the type (fig. 1), No. 12611 U. S. N. M., there are three fragmentary mandibles, No. 12612 (fig. 2). No. 12613 and No. 12615, and a few fragments of limb bones, all from near Hagerman, and in the U. S. National Museum Collection. Two lower jaw specimens, No. 1326 and No. 1327, from near Grand View, belonging to the collections of the California Institute, are also referred to this species. No. 1326, Calif. Inst. Technology Coll., includes the

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[1] J. W. Gidley, Journ. Mammalogy, vol. 11, no. 3, pp. 300–303, 1930.

[2] J. C. Merriam, Univ. Calif. Publ. Bull. Dept. Geol., vol. 10, pp. 524–526, 1918.

greater part of the ramus, the cheek-tooth and the alveolus for the canine This jaw is slightly smaller than that of the type, having somewhat smaller and narrower premolars as in No. 12612 (fig. 2), U. S. N. M. The teeth in the Grand

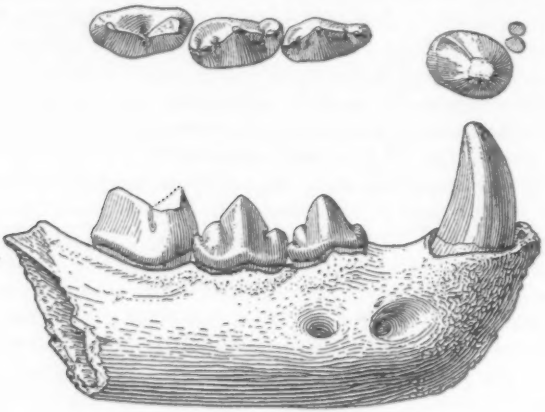

FIG. 1. FELIS LACUSTRIS, NEW SPECIES. RIGHT RAMUS OF MANDIBLE WITH CANINE AND CHEEK-TEETH, TYPE SPECIMEN, NO. 12611 U. S. N. M., LATERAL AND OCCLUSAL VIEWS, × 1

Hagerman lake beds, Upper Pliocene, Idaho. Drawing by Sydney Prentice.

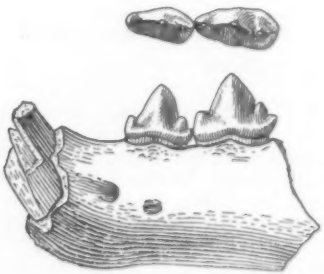

FIG. 2. FELIS LACUSTRIS, NEW SPECIES. ANTERIOR PORTION OF LEFT RAMUS OF MANDIBLE WITH PREMOLARS AND PART OF CANINE, NO. 12612 U. S. N. M., LATERAL AND OCCLUSAL VIEWS, × 1

Hagerman lake beds, Upper Pliocene, Idaho. Drawing by Sydney Prentice.

View specimen are suggestive of lynx, but the canine alveolus is as large as that in the type. The differences are probably not beyond the range of individual variation.

Comparison.—Among the living cats of the western hemisphere *Felis lacustris* appears to resemble most closely the puma, being appreciably larger and having a much more robust canine than the lynx. Outstanding characters that seem to distinguish the fossil from the living puma are the shape of the symphysial portion of the mandible and the relative proportions of the teeth. The symphysis does not project downward below the lower border of the ramus and is rounded anteriorly, making the dorsoventral extent of the symphysis noticeably less than in *F. concolor*. The canine is relatively short and thick with a nearly oval cross-section. The slender crowns of the premolars are narrowed anteriorly and in the type do not show so marked a transverse median constriction as commonly seen in *F. concolor*. The constriction tends to be more anteriorly placed in the fossil form. Furthermore, the lower carnassial in the type is relatively small.

Measurements in millimeters

	Felis lacustris	
	No. 12611 U.S.N.M. type	*No. 1336 C.I.T.*
Greatest length of symphysis of mandible	33.8	31.0
Depth of ramus below anterior end of P_4	22.5	21.7
Depth of ramus below posterior end of M_1	24.0	24.5
Thickness of ramus below middle of M_1	11.0	10.3
Length from anterior end of C to posterior end of M_1	64.1	65[a]
Length from anterior end of P_2 to posterior end of M_1	41.8	38.5
Length of diastema between canine and P_3	10.0	13[a]
C, anteroposterior diameter at base of enamel	12.4	
C, transverse diameter at base of enamel	10.0	
P_2, anteroposterior diameter	12.5	10.1
P_3, greatest transverse diameter	6.5	5.5
P_4, anteroposterior diameter	15.0	13.0
P_4, greatest transverse diameter	7.5	6.2
M_1, anteroposterior diameter	15.7	15.0
M_1, greatest transverse diameter	7.6	7.3
M_1, length of protoconid blade	7.7	7.2

[a] Approximate.

In the development of the symphysial portion of the mandible *Felis lacustris* strongly resembles the type of *Pseudaelurus* (or *Metailurus*) *intrepidus* Leidy[3] from the Miocene of Nebraska. *P. intrepidus* is of comparable size and possesses slender teeth but is more primitive in exhibiting an alveolus for P_2 and a vestigial talonid on the lower carnassial. Also, the carnassial is relatively large, and the canine is less blunt and does not have so nearly an oval cross-section.

Satisfactory comparison of *Felis lacustris* with *Felis hillanus* Cope[4] from the Blanco of Texas can not be made as Cope's type consisted of only an upper canine

[3] Joseph Leidy, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 7, pp. 52, 367, pl. 1, fig. 8, 1869.

[4] E. D. Cope, Fourth Ann. Rept. Geol. Surv. Texas, 1892, pp. 55–57, 1893.

and miscellaneous foot bones. *Felis inexpectata* Cope[5] from the Pleistocene of Pennsylvania and *Felis daggetti* Merriam[6] from Rancho La Brea are puma-like felids but characterized by much greater size and heavier cheek-teeth than is *F. lacustris*. *Felis hawveri* Stock[7] and *Felis bituminosa* Merriam and Stock[8] from the Pleistocene of California though large are more nearly comparable in size to *F. lacustris;* however, the Idaho form possesses a distinctly smaller carnassial and relatively narrower premolars than either of these species.

Machairodus(?) hesperus, new species

Type.—Fragment of mandible with M_1 (fig. 3), No. 12614 U. S. N. M.

Locality.—T. 7 S., R. 13 E., near Hagerman, Idaho.

Horizon.—Hagerman lake beds.

Specific characters.—Size distinctly small. Lower carnassial slender and tapering posteriorly. Protoconid shearing blade long. Angle between paraconid and protoconid shearing blades relatively acute. Very slight vestigial heel or metaconid present. Anterior portion of masseteric fossa extends forward to point below notch of M_1, and upward nearly to tooth cingulum.

Description.—The mandible fragment and carnassial indicate an animal considerably smaller than *Machairodus* (*Heterofelis*) *catocopis* Cope[9] or *Machairodus* (*H.*) *coloradensis* Cook[10] from lower Pliocene beds in the middle west, also much smaller than *Smilodon gracilis* Cope[11] from the Pleistocene of Pennsylvania. The carnassial is relatively slender with the greatest transverse width well forward across the paraconid portion. The shearing blades are only slightly worn and form a sharp angle when viewed from the side. Viewed from above the cutting edges form an angle which appears to be more acute than in *Machairodus catocopis* (topotype, No. 4819 U. S. N. M.), also less obtuse than in either *Smilodon gracilis* or *Smilodon californicus* Bovard.[12] The tooth tilts backward in the jaw more than in true *Felis*, having an attitude comparable to that in *Machairodus catocopis*. In *Smilodon* and in *Ischyrosmilus* the cusps of the teeth are directed backward to a considerable degree.

The masseteric fossa exhibited in No. 12614, U. S. N. M., extends forward to the expansion caused by the anterior root of M_1, and upward in this area nearly to the cingulum of the tooth. The disposition of the anterior portion of the masse-

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[5] E. D. Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 11, pp. 247–249, 1899.

[6] J. C. Merriam, *ibid.*, pp. 535–537, 1918.

[7] Chester Stock, Univ. Calif. Publ. Bull. Dept. Geol., vol. 10, pp. 482–483, 1918.

[8] J. C. Merriam and Chester Stock, Carnegie Inst. Wash., Publ. 422, pp. 215–216, 1932.

[9] E. D. Cope, Amer. Naturalist, vol. 21, pp. 1019–1020, 1887, and see W. H. Burt, Univ. Calif. Publ. Bull. Dept. Geol. Sci., vol. 20, pp. 261–292, 1931.

[10] H. J. Cook, Proc. Colo. Mus. Nat. Hist., vol. 4, no. 2, pp. 1–15, 1922.

[11] E. D. Cope, Journ. Acad. Nat. Sci. Philadelphia, ser. 2, vol. 11, pp. 239–247, 1899.

[12] See J. C. Merriam and Chester Stock, *ibid.*, pl. 2, fig. 4, 1932.

teric fossa is unlike that in true felids but resembles the condition seen in advanced sabre-tooth cats. The masseteric fossa of *Machairodus catocopis* is distinctly more feline than is that of *M.*(?) *hesperus*.

A second metatarsal, No. 12934 U. S. N. M., in the Hagerman collection, referred to *Machairodus*(?) *hesperus*, is noticeably short and robust. This element is about two thirds as long as in *Smilodon californicus* from Rancho La Brea but with relatively wide proximal and distal ends. Furthermore, the portion of the shaft immediately adjacent to the distal end seems relatively shallow dorsoventrally.

A comparison of *Machairodus*(?) *hesperus* with *Machairodus niobrarensis* Thorpe[13] from the Miocene of Nebraska is not feasible due to the different nature

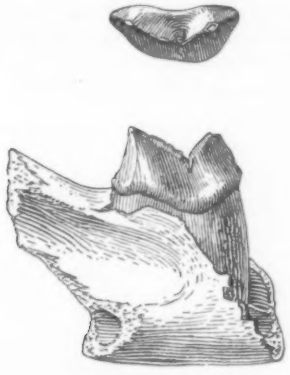

FIG. 3. MACHAIRODUS(?) HESPERUS, NEW SPECIES. FRAGMENT OF RIGHT RAMUS OF MANDIBLE WITH CARNASSIAL TOOTH, TYPE SPECIMEN, NO. 12614 U. S. N. M., LATERAL AND OCCLUSAL VIEWS, × 1

Hagerman lake beds, Upper Pliocene, Idaho. Drawing by Sydney Prentice.

of the materials. The type of *M. niobrarensis* is an incomplete rostral portion of a skull with the root of the canine showing. The two species though possibly of comparable size are apparently separated by a considerable interval of time.

The type of *Ischyrosmilus*(?) *idahoensis* Merriam[14] from near Froman's Ferry in southwestern Idaho as indicated by the root portion of M_1 is nearly twice as large as *Machairodus*(?) *hesperus*. The attitude and shape of the lower carnassial in *Ischyrosmilus*, as shown by the species *I. ischyrus* and *I. osborni*, is more nearly as in *Smilodon*.

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[13] M. R. Thorpe, Amer. Journ. Sci., ser. 5, vol. 3, pp. 448–449, 1922.

[14] J. C. Merriam, *ibid.*, pp. 524–526, 1918.

[15] Otto Zdansky, Palaeont. Sinica, ser. C, vol. 2, fasc. 1, pp. 120–123, 1924.

The form *Machairodus maximiliani* Zdansky[15] from late Tertiary beds in China has a lower carnassial almost as small as that of *Machairodus*(?) *hesperus* but the protoconid blade appears relatively short in this particular Asiatic form. Also, the greatest width of the tooth is across the posterior or protoconid portion, whereas in *M.*(?) *hesperus* the greatest width is farther forward.

In comparison with European forms *Machairodus*(?) *hesperus* is seen to correspond closely in proportions of the lower carnassial with *Megantereon megantereon* (Croizet and Jobert)[16] (= *Machairodus cultridens*) from the upper Pliocene or Pleistocene of Mont Perrier, France and Val d'Arno, Italy. Heretofore *Megantereon* has not been recognized in North America and at present there is no certain evidence to show that the small Idaho machairodont belongs to this genus. The record of late Pliocene machairodonts in North America is rather scant and includes principally occurrences of the relatively large *Ischyrosmilus*. Previous finds referred to *Machairodus* in this country are apparently all from beds of Miocene or lower Pliocene age.

Measurements in millimeters

	Machairodus (? hesperus No. 12814 U. S. N. M. type
Depth of ramus below posterior end of M_1	26.6
M_1, anteroposterior diameter	19.8
M_1, greatest transverse diameter	9.0
M_1, length of protoconid blade	10.5

	No. 12934 U. S. N. M. referred specimen
Greatest length of second metatarsal parallel to shaft	60.1
Greatest dorsoventral diameter of proximal end of second metatarsal	24.5
Greatest transverse diameter of proximal end of second metatarsal	12.7
Greatest transverse diameter of distal end of second metatarsal	17.7

U. S. National Museum, Washington, D. C.

[16] See P. Gervais, Zool. et Paléont. Françaises, Paris, pp. 126–127, pl. 27, figs. 1–2, 1848–52; M. Boule, Bull. Soc. Géol. France, ser. 4, vol. 1, pp. 551–573, fig. 17, 1901; and G. E. Pilgrim, Mem. Geol. Surv. India, n. s., vol. 18, pp. 173–175, table on p. 177, 1932.

GENERAL NOTES

A NOTE ON BASSARISCUS

On a recent trip to Carmel-by-the-Sea there was observed the very much flattened carcass of an adult civet cat, *Bassariscus astutus raptor*, in the middle of the highway. This particular stretch of road was on the new Pruneville highway somewhere about one half to three quarters of the way from Gilroy, Santa Clara County, to Salina, Monterey County, California. The road winds among the hills and through a country that is not as yet thickly settled either by farmers or the ever present highway stands.

The animal had been run over so often and for so long that it was demolished almost beyond recognition; however, the tail was more or less intact, and it was possible to identify the individual with certainty as a *Bassariscus*. As far as is known this is the first instance where a member of this genus has fallen on the highway, a victim of rapid transportation.—Edna M. Fisher, *Museum of Vertebrate Zoology, University of California, Berkeley, California.*

RED FOX ATTACKED BY A GOLDEN EAGLE

I was fortunate enough to witness an attack by a golden eagle upon a cross fox near the East Fork of the Toklat River in Mount McKinley National Park in Alaska on July 8, 1932. While returning from Stony Creek I saw an adult red fox in worn pelage crouching in the open beside the road near a galvanized iron culvert. This fox was very loath to run even when closely approached. At first I could not understand its unusual tameness, but I was soon enlightened by a golden eagle's swooping down at the fox, which speedily sought shelter. Looking into the culvert I found another large male cross fox hiding there. Seeing me he started off down the road at full speed, but before he had covered 100 yards there was a "hiss of wings," and the eagle flew at him like a thunderbolt. Just as the eagle struck, the fox jumped nimbly to one side and thus evaded the eagle's talons. As the eagle descended the second time, the fox fluffed out his tail and stuck it straight up in the air over his back, so that it served as a protecting foil at which the eagle struck, and again missed the fox. The third attack of the eagle was frustrated by a dive into a narrow crack in the solid rock, where I found the fox with his nose just sticking out. He allowed me to approach within three feet of him and even then he would not risk the open again. Instead, he crouched as far back in the shallow crevice as possible, where I left him trembling with his eyes glowing like twin coals of fire.—Joseph S. Dixon, *Wild Life Division, U. S. National Park Service, Berkeley, California.*

NOTES ON THE UNALASKA COLLARED LEMMING (DICROSTONYX UNALASCENSIS UNALASCENSIS MERRIAM)

Dicrostonyx unalascensis was described by C. Hart Merriam (Proc. Wash. Acad. Sci., 2: 25; March 14, 1900) on the basis of skulls extracted from owl pellets taken at Unalaska Island, Alaska. Although, according to Nelson (Proc. Biol. Soc. Wash., Vol. 42, p. 142, March 30, 1929), more than 130 skulls now are available, all were from owl pellets; and, so far as I know, no account has been given of complete specimens. I, therefore, welcomed the opportunity to examine two adult

females trapped September 18 and 19, 1931, in the lower edge of talus at the head of Cascade Creek (local name), two and one-half miles east of the town of Unalaska (see maps nos. 9007 and 9008, U. S. Coast and Geodetic Surv.).

External measurements of these two specimens (nos. 51218 and 51219, Mus. Vert. Zool.) are respectively as follows: Total length, 154 mm., 154 mm.; length of tail vertebrae, 11, 12; length of hind foot including claw, 21, 19. The fore claws on digits 3 and 4 show no thickening. Plantar tubercles are absent.

The coloration may be described as follows: Dorsal surface uniformly buffy brown, almost Saccardo's Umber, and black or gray, with a narrow, median, longitudinal, black stripe, slightly irregular in course and extending from occiput to base of tail; sides, cheeks and tail like back but with less black or gray; belly, throat and hind legs Pinkish Buff to Cinnamon-Buff; shoulders, ear patches, axillary and inguinal regions, and chest, marked with Sayal Brown, or between Ochraceous-Tawny and Cinnamon-Brown; nose black; occiput blackish brown. (All capitalized color terms taken from Ridgway, "Color Standards and Color Nomenclature," 1912.)

Thus it may be seen that *D. unalascensis unalascensis* closely resembles *D. unalascensis stevensoni*, as described from the adjacent Umnak Island by Nelson (p. 145). The only significant difference in coloration between *unalascensis* and the type of *stevensoni* (collected December 14, 1920) is the absence in *unalascensis* and the presence in *stevensoni* of "an irregular dull grayish white patch across posterior part of crown, and grayish white hairs about nose—these last being marks of individual variation" (Nelson, p. 145). Perhaps these white markings, on the specimen taken two months later in the fall than those from Unalaska, are signs of an approaching whitish winter pelage that, even though it does not become pure white, renders the animal conspicuously lighter colored than it is in summer.

Because of the resemblance of *D. u. unalascensis* in general color to *D. u. stevensoni*, and because of the absence of any trace of an in-coming white pelage on the two specimens captured near Unalaska, it seems probable that *unalascensis*, like *stevensoni*, does not turn white in winter. A seasonally comparable specimen of *D. rubricatus*, an immature male taken September 23 at Point Humphreys, Alaska (see Allen, Bull. Mus. Comp. Zool., 62: 521; February, 1919), already showed an intermediate stage between summer and winter pelage.

Persistent trapping for two weeks over all associations adjacent to the mentioned talus produced no more lemmings, though it was expected that they would be found to occur in the same habitat as *stevensoni*, namely, on the hillsides and flats.

One is tempted to speculate whether the brown winter pelage of *D. unalascensis* represents a primitive condition that existed in all collared lemmings prior to the Pleistocene. If so, has the brown winter coat been retained relatively unchanged in this isolated species, or has the brown coat been reacquired? Because of the close relationship of *unalascensis* to the mainland *rubricatus*, which is known to be white in winter as far south as Chignik (Nelson, *op. cit.*, 144), and from which *unalascensis* may have been derived, it seems slightly more probable that the brown coat was reacquired, possibly in response to the comparatively mild winter climate of Unalaska.—RAYMOND M. GILMORE, *Museum of Vertebrate Zoology, University of California, Berkeley, California.*

THE GENOTYPE OF DICOELOPHORUS AMEGHINO

In June, 1888, Florentino Ameghino described, under the name *Dicoelophorus*, a new genus of extinct rodents related to the living "tuco-tucos" *Ctenomys*). To it he referred four species denominated as follows: *Dicoelophorus latidens* (H. Gervais and Ameghino) 1880; *D. simplex* sp. nov.; *D. celsus* sp. nov.; and *D. priscus* (Owen) 1840. All of them were based, so far as he was then concerned, on fossils that he and his brother Carlos had collected during April of the same year at Monte Hermoso, Argentina (Lista de las especies de Mamíferos fósiles del Mioceno Superior de Monte Hermoso hasta ahora conocidas, p. 6, June, 1888; Obras Completas, vol. 5, p. 485, 1916). Ameghino, in 1888, designated no genotype, but he said that the first of the four species was the most abundant of those occurring at the type locality and that it was represented by many specimens, a circumstance that enabled him to give an exact idea of its structure.

In using the name *latidens*, in 1888, for the commonest Hermosan *Dicoelophorus*, Ameghino acted on his belief that he was then dealing with the same rodent that he and H. Gervais had previously described, in 1880, as *Ctenomys latidens* (Los Mamíferos fósiles de la América Meridional, p. 69) from another horizon and locality (Pampean deposits near Buenos Aires). This Pampean species was based on a jaw in the Paris Museum, a specimen that Ameghino is not likely to have had an opportunity to examine during the short and exciting period of less than two months when he was rushing his Hermosan report (with its 3 new genera and 25 new species) into print. It is not surprising that, under such stress, his memory should have played him false, as the event shows it to have done.

But the error that Ameghino made in 1888 was not discovered until 1931, when Rusconi revised the extinct members of the genus *Ctenomys* (Anales Soc. Cient. Argentina, vol. 111, pp. 129–164). Information that Rusconi then received from Professor Boule in Paris showed him that the jaw described by Ameghino and Gervais in 1880 actually pertained to a Pampean *Ctenomys*, and not, as Ameghino wrongly supposed in 1888, to a *Dicoelophorus* identical with the "most abundant" Hermosan species. Rusconi therefore proposed the new name *Dicoelophorus primus* to replace the mistakenly applied *D. "latidens"* that Ameghino had used in 1888 for the Hermosan animal; and furthermore, as there appeared to be no doubt that Ameghino had regarded this "most abundant" species as the genotype, he formally so designated it.

A year later, however, Rusconi reversed his opinion about the two specific names. He then decided that the Pampean animal should be known as *Ctenomys latidens* Gervais and Ameghino 1880, and the Hermosan animal should be known as *Dicoelophorus latidens* Ameghino 1888, with *D. primus* Rusconi 1931 as a synonym (Anales Soc. Cient. Argentina, vol. 114, pp. 198–200).

The fact seems clear that Rusconi, in 1931, complied with the provisions of the International Code, Art. 30, II, e and g. He, exercising the authority of the "first reviser," designated as genotype one of the species originally included in *Dicoelophorus* by Ameghino. The circumstance that Ameghino, in 1888, mistook this "most abundant species" of *Dicoelophorus* for a totally different animal that he had described eight years before, and consequently used a wrong name for it, has no bearing, under any section of the code, on the finality of Rusconi's action.

Rusconi's second decision is based on the assumption that Ameghino, by mis-

takenly using the specific name "*latidens* Gervais and Ameghino" 1880 for a member of his new genus *Dicoelophorus*, actually created a new name. But no article of the Code or opinion of the International Commission supports this assumption.

Therefore the type of *Dicoelophorus* Ameghino 1888 is, by subsequent designation, "the most abundant Hermosan species," which Ameghino in 1888, through misidentification with the *Ctenomys latidens* of Gervais and Ameghino 1880, called *D. "latidens"* (= *D. primus* Rusconi, 1931); and the specific name *latidens* has been given no standing in the genus *Dicoelophorus* either by Ameghino in 1888 or by Rusconi in 1932.

Should subsequent study show that Ameghino's "most abundant Hermosan species" of *Diceolophorus* is not separable from one (or more) of those that had been described before Rusconi published the name *primus*, the reviser who comes to this conclusion must substitute one of these older names for *primus* Rusconi 1931 as the correct technical designation of the genotype.—GERRIT S. MILLER, JR., *U. S. National Museum, Washington, D. C.*

HIGHWAY MORTALITY OF RABBITS IN IDAHO

Mr. Kenneth Gordon's notes on numbers of rabbits killed on an Idaho highway in the summers of 1929 and 1931 (Journal of Mammalogy, May, 1932, p. 169) were of special interest as I have been keeping highway mortality records of vertebrates of all kinds in various States over a number of years.

In September of 1932 I covered by automobile the sections of highway No. 30 (highway No. 40 does not touch Idaho) where Mr. Gordon saw most of his rabbit carcasses. From Boise south I counted 124 jackrabbit and 88 cottontail carcasses in the first 15 miles—an average of 14 per mile. For the next 35 miles the average was still high (11) but was near normal (1½) for the next 80 miles. For 60 miles of the river valley road, between Glenns Ferry and Burley, and on the 10 miles from Preston to the Idaho-Utah line no rabbit carcasses were seen, and only 3 were observed on a 50-mile stretch from Pocatello to Preston. Furthermore, only 7 rabbit carcasses were counted on the 410 miles of highway from Lewiston to Boise.

Thus, the average number of rabbit carcasses per highway mile in Idaho was but slightly in excess of 1 (763 carcasses in 685 miles) even though it includes the greatest highway mortality that I have ever seen, namely, 422 jackrabbits and 176 cottontails, in 50 miles. With the exception of rabbits, the mammal highway mortality for the 685 miles was practically nil, a spotted skunk (*Spilogale*) being the only victim noted.—CHARLES C. SPERRY, *U. S. Biological Survey, Denver, Colorado.*

THE STATUS OF THE WISENT ON DECEMBER 31, 1932

Of the 73 (70) pure blooded wisents in existence on December 31st, 1932, that is, 38 (36) bulls and 35 (34) cows, there were 22 in Germany, 20 in England, 15 in Poland, 7 in Sweden, 4 in Holland, (3 in Russia), and 1 each in Austria and Hungary. The largest herd of all is that of the Duke of Bedford in Woburn Abbey consisting of 20 pure blooded animals and 19 cross breeds. The next largest belongs to Count Arnim in Boitzenburg—Uckermark. In a most beautiful old timber-forest 13 pure blooded animals are kept, carefully fenced in, and with the

exception of one cow they all have Caucasian blood. The herd owned by the Prince of Pless in Upper Silesia has made a good recovery and has increased its number from only three animals left after the revolution to nine, of which four are bulls. The Berlin Zoo owned five pure blooded wisents. In Hanover, Munich, Springe and Stellingen there was 1 bull each.

The breeding efforts in Amsterdam are of a somewhat recent date but look very promising. There is one bull in Wien-Schoenbrunn and one in Budapest of which the one in Hungary is used for cross breeding. It has thus far been impossible to ascertain whether the animals that used to be in Ascania Nova in South Russia are still alive. It seems as if the cow of that region was sterile. The bulls of this breeding place are used in the famous old "supplantation breeding" (Verdrängungs-Zucht).

In Sweden there are, aside from seven pure blooded wisents, five first-class grades with bison blood. Some of the animals are in the Stockholm Zoo on Skansen while the others are in a large game-preserve in Vaestmanland. A few years ago this herd was decreased by a number of these animals—pure blooded ones as well as grades—being sold. Poland took up the breeding of wisents with enthusiasm and understanding. In a small preserve in Bialowies a small stock is tended that now consists of six pure blooded animals and nine grades. The plan is to allow the surplus of this stock to return to a free life in the original forests. Wisent breeding in Poland is a national matter. The stock of this beautiful game having become almost extinct by the end of 1921 it is planned to rear this particular species of game and then return it to its native soil in Poland.

Of course the number of wisents—73 pure blooded animals in all in the whole world is not exactly a large one, yet, it shows quite a considerable increase since we commenced our work. The experience that we have had and the progress we have been able to make during our ten years of activity in this direction leaves us convinced that the wisent of to-day is a healthy and hardy species, quite prepared to maintain itself unless disease should overtake the stock, which, however, is already fairly decentralized and thus safer in respect to contagion. Of late the wisent has often been included in the series of "animals that have become extinct," but it certainly does not belong to that category. And from this point of view the breeding of grades as done in various places is quite interesting but not really necessary. No actual harm is done by using superfluous wisent bulls to cover bison cows and their bastard issue. It is to be deeply regretted however if wisent cows are taken to a grade bull in spite of the fact that sufficient pure blooded wisent bulls are available. In England such procedure led to the result that fifty per cent of the stock are grades: of the 49 animals in Woburn Abbey 19 have traces of the blood of the gray domestic cattle of the steppe of Southern Russia. Without this loss the number of wisents in Europe would have amounted to almost one hundred.

The issue of wisent bull and bison cows and their heifers when bred to a wisent will throw back to the wisent but naturally they will never be a hundred per cent wisent. The experiments have now reached the fifth generation. Of the grades raised in Germany most of the bulls are killed. In other countries this method has not yet been adopted and thus the calamity as regards the bulls, bad enough as it is, is constantly being increased. Everywhere there are superfluous wisent bulls and in addition superfluous grades that have no value what-

ever for breeding purposes. The grade cows on the other hand have some scientific value, as the continuous cross breeding with wisents may some day reveal how many generations are necessary for a proper reversion to the original type. It would be of interest to science as well as an advantage to the European position as regards the wisent if some of the superfluous bulls were given to American zoos for cross breeding. Grade cows would naturally also be available but it would be unnecessary to send these to America where a sufficient number of bison cows can be had as a basis for "supplantation breeding."—ERNA MOHR, *Internationale Gesellschaft zur Erhaltung des Wisents, Zoologisches Museum, Hamburg, Germany.*

FIFTEENTH ANNUAL MEETING OF THE AMERICAN SOCIETY OF MAMMALOGISTS

The fifteenth annual meeting of the American Society of Mammalogists was held at the Biological Institute, Harvard University, Cambridge, Mass., from May 9 to May 13, 1933. There were 66 members present, representing ten states and one Canadian province.

PROGRAM

TUESDAY, MAY 9

8.00 *p.m.*

Meeting of the Board of Directors at the Harvard Faculty Club

WEDNESDAY, MAY 10

9.30 *a.m.*

Address of welcome. George H. Parker, director of the zoological laboratories of Harvard University.

1. A statistical study of the genus *Myotis*. H. Anthony Carter.
   Discussed by M. W. Lyon, Jr., W. C. Henderson, T. S. Palmer, and V. Bailey.
2. The problem of water conservation by desert mammals. A Brazier Howell.
   Discussed by M. W. Lyon, Jr., R. Kellogg, and V. Bailey.
3. The morphology of the mammalian erythrocyte in the light of comparative haematology. A. B. Dawson.
   Discussed by M. W. Lyon, Jr., T. S. Palmer, and R. Kellogg.
4. Are there sixty thousand antelopes in the United States and Canada? T. S. Palmer.
   Dicsussed by W. C. Henderson, H. J. Coolidge, Jr., V. Bailey, and M. W. Lyon, Jr.
5. Notes on mammal collecting in tropical Australia. Philip J. Darlington.
   Discussed by M. W. Lyon, Jr., and T. S. Palmer.
6. Fall food habits of coyotes, a report of progress, 1932. Charles C. Sperry (read by W. C. Henderson). Discussed by J. M. Johnson.

2.15 *p.m.*

7. Note on the shedding of the deciduous horn in a young pronghorn antelope. C. V. Noback.
   Discussed by T. S. Palmer, M. W. Lyon, Jr., and V. Bailey.
8. Notes on Tanganyika mammals. Arthur Loveridge.
9. Panniculus carnosus in an octodont rodent. Robert K. Enders.
10. Wild-animal damage to New England forests. Neil W. Hosley.
    Discussed by W. J. Hamilton, Jr.
11. Herluf Winge's theory of tooth cusps. Elisabeth Deichmann.
    Discussed by G. M. Allen.
12. The dentition of the walrus (*Odobenus obesus*). W. Montague Cobb.
    Discussed by G. M. Allen and R. Kellogg.
13. The importance of types and type localities in the study of mammals. Vernon Bailey.
    Discussed by T. S. Palmer.
14. Report of activities of the American Committee for International Wild Life Protection during the past year. Elizabeth Hone.

THURSDAY, MAY 11

9.30 *a.m.*

15. An indirect inherited effect of an inherited character in mice. Sheldon C. Reed.
    Discussed by M. W. Lyon, Jr., and T. S. Palmer.
16. Congenital hydrocephalus in the house mouse. F. H. Clark.
17. Our fragmentary knowledge of heredity in mammals. William E. Castle.
    Discussed by T. S. Palmer and G. M. Allen.
18. The inheritance of white spotting in mice. C. E. Keeler.
19. An interesting pocket gopher from Honduras. Barbara Lawrence.
    Discussed by G. M. Allen, V. Bailey, M. W. Lyon, Jr., and W. E. Castle.
20. Life Zones in Indiana. Marcus Ward Lyon, Jr.
    Discussed by T. S. Palmer, Vernon Bailey, and G. M. Allen.
21. Evolution of the Giraffidae. E. H. Colbert.
    Discussed by T. S. Palmer and G. M. Allen.
22. Notes on the giant panda and the takin. Brooke Dolan.
23. Notes on the okapi. Patrick T. L. Putnam.
    Discussed by H. J. Coolidge, Jr., J. P. Chapin, and M. W. Lyon, Jr.
24. High-speed photography. H. E. Edgerton.
25. Some mammals of the middle Congo. James P. Chapin.
    Discussed by H. J. Coolidge, Jr.

2.15 *p.m.*

26. Report on the presence of four nipples (polythelia) in a living five and one-half year old female chimpanzee. Symmetrical supernumerary mammae in a living chimpanzee. C. V. Noback.
27. Observations on gibbons and siamangs. Adolph H. Schultz.
    Discussed by C. V. Noback and G. M. Allen.
28. Pan paniscus, the new pygmy race of chimpanzees from south of the Congo. Harold J. Coolidge, Jr.
    Discussed by J. P. Chapin.

29. The growth and changes in the New York Zoological Society's gorilla. C. V. Noback.

3.30 *p.m.*

Annual Business Meeting of the Society

7.00 *p.m.*

The annual dinner of the Society was held at the Harvard Faculty Club. Following the dinner motion pictures of African elephants were shown by Gouverneur M. Phelps, Jr., and of takin and blue sheep hunting in the highlands of Western China by Brooke Dolan.

FRIDAY, MAY 12

9.30 *a.m.*

30. Myology of the head and neck of Giraffa. E. H. Colbert.
    Discussed by T. S. Palmer.
31. A detailed study of the structure and relationships of a new fossil zalambdodont insectivore. Erich M. Schlaikjer, Jr.
    Discussed by Glover M. Allen, T. S. Palmer, and M. W. Lyon, Jr.
32. Breeding habits and young of the woodchuck, *Marmota monax rufescens*. W. J. Hamilton, Jr.
    Discussed by V. Bailey and M. W. Lyon, Jr.
33. The isolation factor in the evolution of species. E. A. Goldman (read by W. C. Henderson).
    Discussed by M. W. Lyon, Jr., E. H. Colbert, H. H. T. Jackson, C. F. Batchelder, G. M. Allen, H. C. Raven, and W. C. Henderson.
34. Notes on the habits of East Indian pigs. Harry C. Raven.
35. A collecting trip across northern Mexico. Frederic Winthrop, Jr. (read by Vernon Bailey).
36. A preliminary study of the growth and development of the deer mice of the genus Peromyscus. Arthur Svihla (read by Glover M. Allen).

2.15 *p.m.*

37. The least weasel in Indiana. Marcus Ward Lyon, Jr.
    Discussed by T. S. Palmer.
38. The least weasel a circumpolar species. Glover M. Allen.
    Discussed by T. S. Palmer and W. E. Saunders.
39. The weasels of New York: their natural history and economic status. W. J. Hamilton, Jr.
    Discussed by G. M. Allen, V. Bailey, T. S. Palmer, M. W. Lyon, Jr., and W. C. Adams.

3.15 *p.m.*

Final Business Session of the Society

4.00 *p.m.*

A reception and tea was tendered the members of the Society by the Boston Society of Natural History at 234 Berkeley Street, Boston.

8.30 *p.m.*

40. A well attended public session was held in the auditorium of the Institute of Geographical Exploration, at which Harry C. Raven showed motion pictures and exhibited the famous pet chimpanzee "Meshie."

At the meeting of the Directors on May 9, H. H. Lane being absent, W. E. Saunders was appointed Recording Secretary *pro tem* for all sessions. W. Reid Blair was elected a trustee to succeed F. C. Walcott. H. H. Lane, Recording Secretary since the founding of the Society, presented his resignation and by unanimous vote was thanked for his long and efficient services. The present editorial board was reappointed.

At the annual business meeting the election of officers resulted as follows: president, Vernon Bailey; vice-presidents, T. S. Palmer and H. E. Anthony; corresponding secretary, R. T. Hatt; recording secretary, R. K. Enders; treasurer, Mrs. Viola S. Snyder. Directors for 1932-34 were elected as follows: Joseph Grinnell, Remington Kellogg, A. Brazier Howell, W. E. Saunders, Harold J. Coolidge, Jr.

The following summary of membership and subscription conditions was presented:

New members elected at the current meeting	49
New subscribers added since last meeting	8
Total gross additions to mailing list of Journal	57
Resignations since last meeting	47
Deaths reported since last meeting	10
Number of members delinquent, 1933 dues	126
Number of members delinquent, 1932 dues	80
Number of honorary members	4
Number of life members	56
Number of annual members	827
Total present membership of the Society	888
Number of subscribers	146
Present mailing list of the Journal	818

Considering the extremely adverse financial condition of the country, it was to be expected that the Society would continue to suffer loss in membership and Journal subscriptions, as announced at the previous meeting. It is gratifying to report, however, that this loss has not been as great as might have been anticipated, largely because of the loyalty of the Society's membership and particularly the activity of a few of the members in proposing new names for election.

The Society has suffered a severe loss in the deaths of ten members, seven of whom were charter members: *Outram Bangs, *Fred E. Brooks, *Norman Criddle, *Barton W. Evermann, *W. J. Holland, Ernst Huber, *Charles W. Richmond, *Hermann von W(echlinger) Schulte, James E. Thurston, and Lemuel F. Woodward.

Reports of the various committees were read and adopted.

REPORT OF THE SPECIAL COMMITTEE ON PROBLEMS OF PREDATORY MAMMAL CONTROL

No recent developments in the status of predatory mammals and their control have come to the attention of your committee on problems of predatory mammal control. At present the committee has no funds for any extended investigations of its own and, perforce, has acted as a more or less passive clearing house for any data that may be brought to its attention by observers who are so situated as to be able to gather pertinent facts.

Your chairman has not had brought to his attention any evidence to show that the problems of predatory mammal control were aggravated during the year since the last meeting of the Society. On the contrary, the restrictive forces of the economic depression appear to have somewhat curtailed the intensity of control campaigns. The over-production of agricultural products should be an effective argument against expenditure of public funds in the attempt to create an even greater surplus. If the control campaigns mean greater production for the farmer, a debatable issue, present conditions do not justify the campaigns, and if they do not increase production they should never have been started in the first place.

Your committee believes that the Society would welcome a considerable decrease in the use of poison by Federal, State and other agencies, and expresses the hope that for the wild life of America our present financial crisis may have a silver lining. If, as a result of these times, the pressure for over-control of mammals brought by an organized minority is remitted even temporarily, the forces of conservation may hope to consolidate public opinion in opposition to the former wasteful methods. In the meantime, it is hoped that any members of the Society who are able to do so will record any possible direct evidence bearing upon these problems and will use every influence to spread the doctrine that America should be made as safe for our native wild life as for our sheep herders or for any other restricted class.

Respectfully submitted,
H. E. Anthony, Chairman
Lee R. Dice
E. Raymond Hall
M. P. Skinner

REPORT OF THE COMMITTEE ON ECONOMIC MAMMALOGY

The Committee on Economic Mammalogy has in the course of the year endeavored to discharge its duty to the best of its ability in the circumstances. However, with one member residing in New York State, one in Michigan, one in Oregon and the remaining two in California, the difficulties of effective committee work will doubtless be appreciated.

In considering what matters might properly come within its scope the committee has found a little difficulty in drawing sharp boundaries. It is feared that it may have trespassed upon the domain of another committee when, for example, it has referred to the preservation of certain mammals threatened with extinction. Yet it is felt that the forces bearing adversely upon these mammals are essentially economic in origin and for that reason it is hoped that and apparent or real overlapping in this report may be pardoned.

The following matters seem to the committee to deserve the attention of the Society and are presented for such consideration as it may see fit to give them.

I. *Better protection for fur-bearing animals.* It is well known that our fur-bearing animals have long been in need of better protection and that some of the most valuable species such as the marten, the fisher, the otter, the wolverine and the kit fox, especially, in many parts of their range have been reduced to an extent to threaten their virtual if not actual extinction. The committee feels, therefore, that better protection for these species is one of the urgent problems at the present time, and an end toward which the Society should exert any influence that it may command.

II. *Control of shipment of wild mammals.* The uncontrolled shipment of native wild mammals from one part of the country to another for stocking or transplanting purposes has likewise long been a question of some concern to many naturalists. It would seem not only desirable but important that traffic in our wild mammals for such purposes be regulated and controlled by some duly constituted federal agency.

III. *Safeguarding our larger mammals.* The committee desires further to point out the need for adequate areas for the preservation of certain of our larger mamals that under existing conditions are in danger of extinction in the not distant future. The reference is particularly to such forms as the collared peccary, the Texas bighorn and the tule elk, but others are also concerned. To safeguard these species against threatened extinction means not merely the maintenance here and there of a few individuals, under more or less precarious circumstances of existence, but their preservation in sufficient numbers in areas of sufficient size and sufficient carrying capacity, ranging ground and other requirements to insure their sound, healthy condition and to avoid the possibility of recurring excessive concentrations, scarcity of food or other situations that tend to reduce their vitality and expose them to the ravages of diseases.

Other mammals facing serious conditions are the antelope, the elk and the mule deer of the Northwest, regarding which the Oregon member of the committee (S. G. Jewett) reports as follows:

"Serious problems are growing relative to the preservation, first, of the antelope and, second, of the elk. We have positive evidence of a considerable loss of deer through parasitic and possibly other diseases. In some areas we are fast approaching a second Kaibab condition on the principal mule deer and elk ranges."

The committee feels that it would be highly desirable to have this situation looked into by the Biological Survey.

As a step toward safeguarding the collared peccary and the Texas bighorn, the committee would recommend that the Society exercise any influence it may possess in support of a proposal made to the National Park Service by George M. Wright, October, 30, 1931, to extend the Carlsbad Cavern National Park to include the higher Guadalupe Mountains, thereby bringing within its boundaries the type locality of the Texas bighorn, along with an estimated hundred or so of this rare form that still exist in these mountains. Deep canyons and foothills that by such extension would fall within the park boundaries are considered ideal habitat for the peccary, which then could be reintroduced into these former haunts and thus doubtless saved from impending extinction.

With reference to the tule elk of California, the remaining numbers of which

are estimated at about four hundred, all told, the situation is somewhat different but no less serious. A small herd has been cared for in the Yosemite, for a number of years, but as a temporary measure only. The Fish and Game Commission of California, to the extent within its available means, has provided a fenced refuge for these elk in the Button Willow area of Kern County, where approximately a hundred can be maintained. However, these measures, aside from being of temporary nature only, obviously are insufficient to insure the preservation of this elk. The pressing need for this animal is an *adequate permanent preserve within its natural range.*

IV. *Laws and legislation.* A perennial source of danger to some of our mammals of economic importance lies in the many unwise or vicious measures proposed for enactment during the legislative sessions of states. It is recognized that this is a rather difficult problem to meet, and that probably not many members of the Society may be in position to take active part in opposing bad or supporting good legislation in their respective states; but something may doubtless be accomplished by working upon their district representatives. The committee desires merely to mention this question as one deserving thought and attention by members of the Society and all others interested in mammals of economic importance.

V. *Question of Committee's usefulness.* The committee realizes that beyond reporting its views or findings relative to matters falling within its province, it has little functional significance. It is without power to effect action on any matter and without means to promote any cause that it may deem worthy. It can only report, suggest or recommend.

This committee might justify its existence by directing the attention of the Society to important situations or developments confronting mammalian species of direct or indirect economic significance. Other members of the Society should be willing to cooperate to the extent of reporting to the committee, for its consideration, any important situations or developments that might occur in their respective sections. If any plan of this sort should appear worthwhile it might be better to present the committee's views, through the medium of the Journal, by submitting from time to time brief articles or reports, on matters that in its judgment warrant being brought to the attention of the Society.

Respectfully submitted,

GEORGE M. WRIGHT
STANLEY G. JEWETT
M. P. SKINNER
ADOLPH MURIE
CHARLES E. JOHNSON, Chairman

RESOLUTION CONCERNING THE BLACK BEAR IN NEW HAMPSHIRE

WHEREAS, the American Society of Mammalogists takes cognizance of the value and interest of the black bear and believes that in all sections of its range it should receive some measure of protection, and also

WHEREAS it has been noted in the press that the Commissioners of Fish and Game of the State of New Hampshire have recommended to the State Legislature a bill placing the black bear on the list of game animals, and that the House of Representatives passed such a measure.

Therefore Be It Resolved, That the Society in Convention assembled requests the Senate of the State of New Hampshire to take such action as will remove the black bear from the bounty list to the status of a semi-protected game animal.

REPORT OF THE COMMITTEE ON CONSERVATION OF LAND MAMMALS

Your committee, during the past year, has functioned on an investigation into the status of the wapiti on the Olympic Peninsula.

In a letter dated Nov. 25, 1932, your chairman was informed by Mr. F. W. Mathias, the manager of the Grays Harbor Chamber of Commerce, that there was an undue amount of poaching and illegal killing of the Olympic elk. He reported that the animals were being killed for their teeth and the carcasses left to rot in the woods. He appealed to me as a member of the American Museum of Natural History to assist in whatever manner possible in correcting this exploitation of wild life. Rumors that this killing was going on had previously been received, but this Grays Harbor correspondence was the first tangible evidence brought to our attention.

The members of your committee were then placed in possession of such information as had reached the American Museum of Natural History, and the Grays Harbor people were notified that the Committee on Conservation of Land Mammals would be very glad to learn as much as possible regarding the situation and to offer such support as was possible for them to give.

A resolution addressed to the President of the United States had been passed, deploring the conditions on the Peninsula, by the Olympic Peninsula Development League, and on Dec. 6, 1932, your chairman received a report of the special elk committee appointed by the Olympic Development League, a copy of which is enclosed with this report and offered for your information.

Correspondence was also carried on with the U. S. Forest Service, the U. S. Biological Survey, with Mr. S. F. Rathbun, Director, Department of Game, State of Washington, and with other interested parties. Your chairman reported on the situation to the Boone and Crockett Club, at their annual meeting, and presented a resolution deploring any excessive killing of the Olympic elk, which was passed, and a special committee of the club was appointed to keep in touch with the situation.

A similar resolution was passed by the scientific staff of the American Museum of Natural History, and still another by the New York Zoological Society.

Your committee has, without exception, encountered a very gratifying response not only from those institutions and individuals who are active in the fight for conservation, but also from those to whom this problem has other aspects than those of conservation. At all times your committee has striven to keep an open mind as to the actual circumstances on the Olympic Peninsula. While there has been every reason to believe in the sincerity and good intentions of the men on the ground who are asking for more protection for the elk, your committee has been moderate in its expression of sentiment because it realizes that a great deal of the evidence is still in the hearsay stage. It has not, however, hesitated to voice opposition to any excessive killing and has urged that the elk be given every possible protection, with which thesis there can be no argument.

The Chief of the Forest Service, within whose jurisdiction most of the area in question lies, has assured your chairman of his gratification that the society is

interesting itself in the problem of the Olympic elk. The evidence in his possession indicates that the reports of killing are exaggerated, but he believes that there is need for an investigation to afford a census of the elk, a survey of conditions of summer and winter ranges, areas where poaching is known to occur, etc., and it seems to your committee that such a study would be the best constructive attack upon the problem.

A complication of the situation is the fact that the State of Washington has changed its policy of game administration during the year, changing from county to state control.

In brief, your committee believes that a real problem exists on the Olympic Peninsula and that the society should encourage an early investigation of the status of the Olympic elk and should use its influence to bring about any necessary action.

Respectively submitted,

H. E. Anthony, Chairman
Lee R. Dice
Madison Grant
Joseph Grinnell
T. S. Palmer

RESOLUTION OFFERED BY COMMITTEE ON CONSERVATION OF LAND MAMMALS

Whereas, the American Society of Mammalogists has been advised by the Committee on Conservation of Land Mammals that certain residents of the Grays Harbor district are greatly concerned over reported illegal killing of the Roosevelt wapiti on the Olympic Peninsula, and

Whereas, the Committee has learned from other sources that there is a real need for a thorough investigation of the conservation problems on the Olympic Peninsula, therefore,

Be it resolved, that the American Society of Mammalogists endorses heartily any study into the status of the wapiti on the Olympic Peninsula and urges that the interested parties carry on such investigations at the earliest opportunity.

Be it further resolved, that the American Society of Mammalogists deplores any illegal killing of the Roosevelt wapiti whether for food purposes or for the sake of the teeth, and expresses the hope that any such activities will be promptly suppressed.

Be it further resolved, that a copy of this Resolution be sent to the Olympic Peninsula Development League and to such other institutions in the State of Washington as are most intimately associated with this problem in order to assure them of the great interest that the American Society of Mammalogists has in the preservation of the Olympic wapiti, and to promise every coöperation of which the Society is capable.

RESOLUTION REGARDING A PUBLICATION ENTITLED "MORE GAME BIRDS BY CONTROLLING THEIR NATURAL ENEMIES"

Whereas it has come to the attention of the American Society of Mammalogists that "More Game Birds in America" has issued a publication titled: "More Game Birds by Controlling their Natural Enemies" in which foxes, skunks,

weasels, raccoons, opossums and red squirrels are listed as "vermin" and instructions given for the destruction of these animals, and

WHEREAS, it is the conviction of the Society that the economic worth of most if not all of these animals far outweights the loss caused by their occasional depredations on game-bird populations,

Therefore Be It Resolved, That the Society in Convention assembled expresses its disapproval of the propaganda contained in the publication named and urges all members of the Society to exert every effort to counteract the effects of this presentation of such an important wild life problem.

RESOLUTION CONCERNING THE RECENT CURTAILMENTS IN THE BIOLOGICAL RESEARCH WORK OF THE UNITED STATES BIOLOGICAL SURVEY

WHEREAS the biological research work of the Bureau of Biological Survey, U. S. Department of Agriculture, including research in the migratory movements, distribution, life habits and relationships of wild animal life is of great importance to all the American people, and

WHEREAS, because of changing conditions, these investigations must be continued as a basis for the conservation and proper use of this great natural resource, which has an estimated annual value of at least $1,000,000,000 and is of inestimable importance from a recreational and esthetic point of view, and

WHEREAS the continuance of these studies is increasingly more essential to the proper discharge of all activities of the Biological Survey, and

WHEREAS, this biological scientific work has already been greatly restricted on account of decreased appropriations made necessary by the financial situation,

Therefore Be It Resolved, That the American Society of Mammalogists, an international organization consisting of members from all parts of the United States and Canada, as well as other foreign countries, does hereby urge upon the President of the United States, the Director of the Bureau of the Budget, and the Secretary of Agriculture, the importance of continuing the biological research activities of the Biological Survey without further curtailment over the present appropriation, inasmuch as the sum now available represents a comparatively small percentage of the total appropriation for this Bureau, and that additional funds be provided for such work as soon as the financial conditions of the country permit. The Society also moves that copies of this resolution be mailed promptly by the Secretary of the Society to the President of the United States, the Director of the Bureau of the Budget, and to the Secretary of Agriculture.

The Editorial Board, heeding the lowered income of the Society, slightly reduced the number of pages printed in the Journal of Mammalogy during 1932. During that year 402 pages were printed in contrast to 461 of the previous year.

During the year the Society has, as usual, cooperated with certain other scientific bodies. At the Syracuse meeting of the American Association for Advancement of Science, C. E. Johnson and C. C. Adams served as councilar representatives, whereas similar capacities were fulfilled by W. B. Bell and R. K. Enders at the Atlantic City meeting. The Society was represented by R. K. Enders at the meeting of the Union of American Biological Societies. Remington Kellogg has continued as observer in the Division of Biology and Agriculture of the National

Research Council. R. T. Hatt attended the meetings of the Game Policy Committee of the American Game Conference as the Society's representative.

The Society also expressed by resolution its thanks and appreciation to Thomas Barbour, Glover M. Allen, Harold J. Coolidge, Jr., Frederic H. Kennard, and John C. Phillips of the Local Committee for their excellent work in providing for the comfort and convenience of the members and for the splendid program and enjoyable entertainment provided at the meeting.

An invitation extended by the American Museum of Natural History to hold the annual meeting of 1934 at New York was unanimously accepted and the determination of the exact time of the meeting left in the hands of the Local Committee.

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COMMENT AND NEWS

ACTIVITIES OF THE AMERICAN COMMITTEE FOR INTERNATIONAL WILD LIFE PROTECTION DURING 1932–33

Report for the American Society of Mammalogists' Annual Meeting, May 10, 1933

The American Committee for International Wild Life Protection is in the fourth year of its existence, and has an official representative of the American Society of Mammalogists on its advisory board, namely, Dr. Joseph Grinnell of California.

The Committee is just publishing a report on the Wood Bison park of Canada by Dr. Hugh M. Raup, research associate at the Arnold Arboretum of Harvard University. Copies of this report will be available to members of the society or to other interested persons who apply to our office at the Museum of Comparative Zoology.

The committee also hopes to issue later this spring a publication on Africa, including a map of all game reserves and national parks on that continent, with

faunal notes on each area, and a series of supplementary articles on the present status of 16 species which are either rare or in an unsatisfactory condition as regards their numerical status. Copies of this will also be available free of charge to interested persons.

Since last November the office has been gathering data on wild life protection in all countries of the world through various sources, and has already received a quantity of interesting and valuable material. We have also been establishing new contacts and re-affirming former ones in many different countries with organizations and individuals who recognise the value of conserving wild life. We have been in active correspondence with regard to the wild life poisoning campaign in Bulgaria, and the possibilitiy of securing European bison for re-introduction into that country. We have been in touch with the Norwegian Fish and Game Association and others in regard to the precarious status of their bear, elk, etc. There is no measure for protecting bear in Norway except a closed season for the first 15 days in November, in spite of constant efforts by the association just mentioned. That organization has offered to pay for all damage done by the animals, but to no avail. It is estimated that not more than 20–25 bears survive south of Trondjhem Fjord.

We have reviewed for some American publications Mr. Theodore Hubback's remarkable and thorough survey of wild life conditions in Malaya. This 3 volume document has splendid maps and recommendations for parks and game laws in the shape of draft enactments complete down to the last detail. The survey cost about $4500 and entailed travelling some 7300 miles.

We have received from the British Society for the Preservation of the Fauna of the Empire a copy of the excellent survey of game conditions in West Africa made for them by Col. A. H. W. Haywood. This is being published serially in the journal of the Society.

The third bulletin of the International Committee for Bird Preservation, which appeared recently, is full of valuable and interesting information for conservationists. We are momentarily expecting to receive a copy of the monumental "Synopsis" of all European laws relating to wild birds, which is being prepared by the International Office for Nature Protection at Brussels.

We are keeping in close touch with developments of the nagana situation in Africa, and spreading reports of recent discoveries along this line to anyone to whom we think such information might be of use. Requests for copies of our 1931 publication on nagana continue to come in, and we should be glad to know through members of this society of anyone who would like a copy.

Last fall we heard disquieting rumors of the proposed abolition of the Zululand reserve where the only white rhinos in South Africa now survive. This was advocated on the grounds that the reserve harbored tsetse fly which constituted a menace to neighboring settlements because, as we all know, these insects carry the cattle disease nagana and human sleeping sickness. We immediately brought pressure to bear on several points of influence, and though the reserve is not yet out of danger, we believe that the strong expression of outside opinion may ultimately play some part in forestalling the abolition of the white rhino sanctuary.

We are in close touch with the energetic Conseil International de la Chasse whose headquarters are in Paris. This organization is rapidly becoming a real power among European forces for conservation, and might well have official

representation in the United States. In fact, we have been requested by it to use our influence to this end.

In spite of reduced budget we were able to send this new organization, as well as the British fauna society, a small contribution in token of our goodwill and appreciation of the fine work they are both doing along lines of interest to us all. We are likewise able to contribute to the running expenses of the International Office at Brussels, which continues to give us invaluable help in many ways, particularly in the preparation of our forthcoming publication on African game reserves and rare African mammals.

In addition, we have given time to a number of matters, such as the present status of the Asiatic rhinoceroses; the massacre of 4–5 adult gorillas incidental to a photographic expedition to the Congo; the status of the Kamchatka sable; the re-appearance of the Pacific sea-otter; the Cuban flamingo traffic; faked nature films, etc.

We have been able to reach a wide body of sympathetic observers in all parts of the world through the courtesy of the London *Field*, *East Africa* and other periodicals which have published our letters soliciting information from their readers on various phases of wild life protection.

Last year we applied for a research grant to enable a competent biologist to prepare a report on the whole question of international agreements affecting wild life, in order to stimulate sufficient interest to lead up to a renewal of the London Convention of 1900 for the preservation of African wild life. However, we have not yet succeeded in securing the funds for the study, but we hope for success at some future time. Meanwhile we are working through many other channels for better international correlation and co-operation in the field of wild life preservation.

Information continues to come in on the present status of the musk-ox, and we hope next fall to publish a comprehensive and unbiased report on the whole problem. And at any time we should welcome suggestions or data that would forward our study from members of this society, as well as names of people who might like a copy of the completed report.

The Canadian musk-ox seems to be holding its own in places where it still occurs within the Arctic Islands Preserve. The same may be said of the animals in the Thelon sanctuary on the mainland, provided the Canadian government can continue to keep wardens patrolling this area of 15,000 square miles against white and Indian poachers. The 34 Greenland musk-ox bought by our government for introduction into Alaska seem to be flourishing on a 6000 acre tract near Fairbanks. Only 5 have been lost so far through various causes. The animals are still apparently too young to breed. In Greenland itself the animals are found today in small scattered herds only in the northeastern third of the narrow coastal strip fringing the ice-cap. Until the World Court decision which early in April gave the sovereignty of this part of Greenland to the Danes, the musk-ox and other members of the local fauna suffered indirectly in the course of mutual recriminations between Norwegian and Danish trappers. Although it cannot be proved with certainty that the Norwegians shipped salted musk-ox beef to Norway and elsewhere, or fed musk-ox to foxes on their Greenland fox farms, it seems certain that they have been very active in hunting calves for zoological gardens and for purposes of introduction into other countries.

Perhaps it is unnecessary to add that this practice entailed frightful slaughter of adult musk-ox, for the only way the animals combat danger is to assume their traditional circle of defense with heads to the front and the calves in the center. The old ones cannot be driven off, and there is apparently no way to break through the circle of horns except to shoot every adult. As the proportion of young ones to each herd is pitifully small, it is no wonder that such massacres repeated enough times to secure, for instance, the 30-odd calves taken in the summer of 1930, may soon bring the Greenland musk-ox close to the danger-line of extinction. In most cases, unfortunately, the animals do not long survive transplanting, or live very long in zoological gardens. With a range in 1800 as great as that of the plains buffalo, according to Seton, these cattle of the arctic prairies had an estimated population of one million. In 1930, according to careful estimates made by Canadian zoologists, this number had dwindled to a total of 14,000 for the whole world. The ancient lineage of the musk-ox and its unique position in the animal kingdom combine to make it of great scientific value and interest. But at the same time a source of weakness lies in the fact that in the course of thousands of years the animal's habits have become so fixed that it has little adaptability to new conditions. The musk-ox is therefore helpless before modern hunters and is certainly doomed to speedy extinction where it is at all accessible and where real protection is lacking.

We feel strongly that in times like these, game animals may be in great danger because of economies in game departments, and a more vital need for game as a primitive food supply. But on the other hand, flooded markets diminish organized opposition to far-reaching measures of international action for controlling whaling, and the ivory, plumage and fur trade, all of which must eventually be regulated by international agreements.

The committee therefore feels that there is an increasing need for what might be called an American clearing house for better understanding of international wild life problems. So far we have been able to carry on our work with the help of various members and member-organizations represented on our advisory committee. But, as in most cases, the amount we can accomplish depends directly on the support we can get. We believe that as our work becomes more widely known we will not fail to secure this help and so be able to continue a work which more and more shows itself to be distinctly worth while.

Respectfully submitted,

ELIZABETH HONE.

OUTRAM BANGS

Outram Bangs, who died on September 22, 1932, was from early youth imbued with that ardent delight in living things that marks the real naturalist. He was born at Watertown, Massachusetts, January 12, 1863, the son of Edward and Annie Outram Bangs; prepared for college at Noble's School, Boston, and graduated from the Lawrence Scientific School of Harvard College in the class of 1884. Already as a mere lad, he had begun a collection of mammals, the earliest specimens listed in his private catalogue having been taken in 1873. In 1892 his interests took more definite shape, and in company with his brother, Edward A. Bangs, he began actively building up a collection of North American mammals both by purchase and through his own field work. Except for one or two trips to Florida and North Dakota, he collected mainly in New England and the eastern provinces of Canada, but at various times employed collectors, such as Ernest Doane, W. W. Brown, F. L. Small, C. H. Goldthwaite, and others, to make collections for him in other parts of the east. By 1899 he had one of the finest private collections in the country amounting to over ten thousand specimens. Between 1894 and 1899 he had published fifty papers on mammals, for the most part brief, describing new forms and recording field notes. The longest contribution was a list of the mammals of peninsular Florida. In 1899 his collection of mammals, including some hundred or more types, was purchased for the Museum of Comparative Zoölogy, where at the same time he was appointed assistant in mammalogy with charge of the collection. But his principal interest now centered more and more on birds, of which he still maintained a splendid collection numbering in 1908 over 24,000 skins, when it too, was acquired by the Museum. Here as assistant and later as Curator, he devoted the rest of his life to building up a representative collection of the birds of the world which now ranks among the foremost in this hemisphere. An outstanding figure in the "renaissance" period of modern mammalogy, generous to a fault, ever vital, helpful and cheery, he was withal so reticent of public appearance, that the full worth of his talents was seldom fully appreciated save by those who knew him well.—Glover M. Allen.

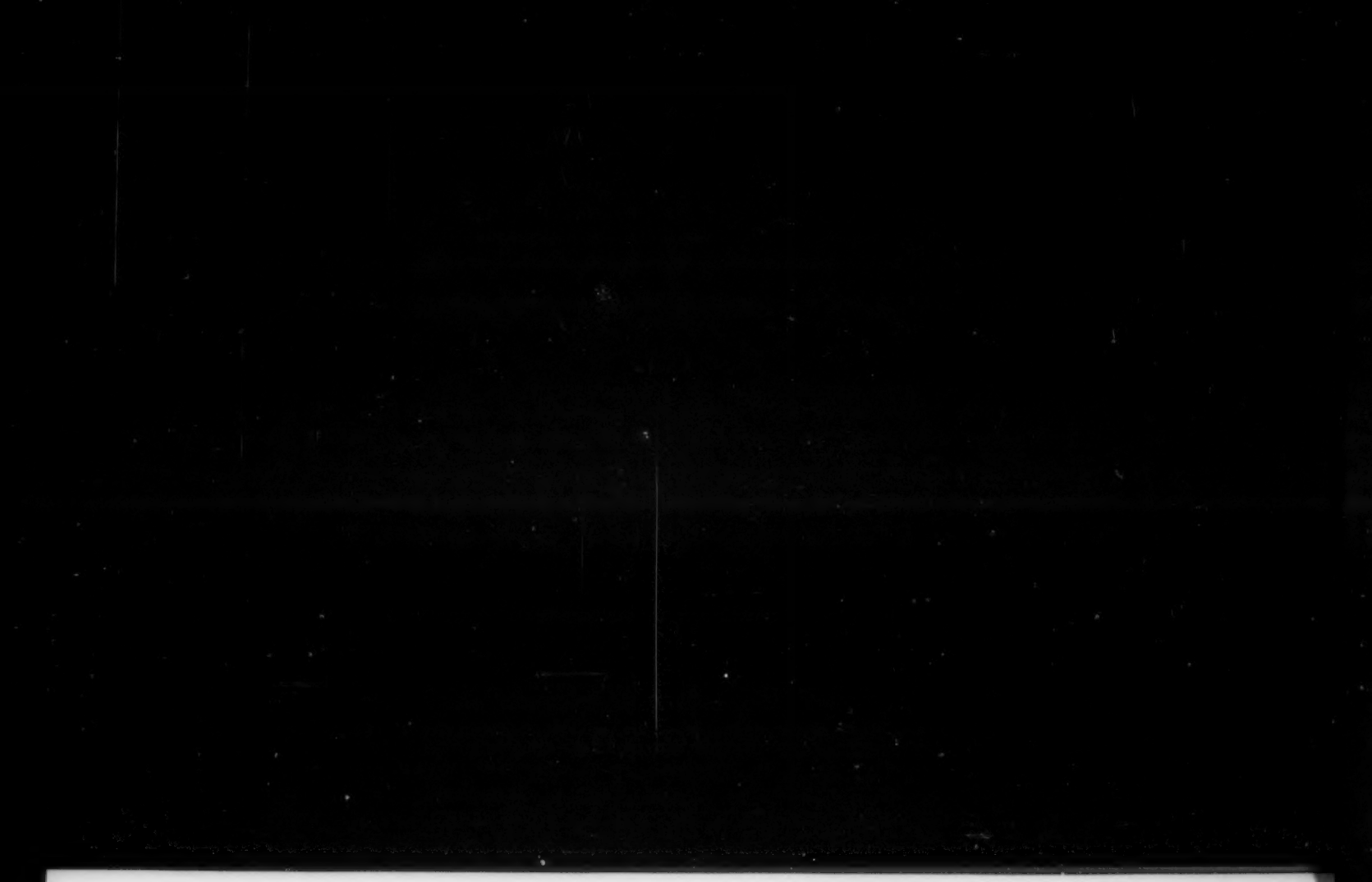
WILLIAM JACOB HOLLAND

It is with deepest regret that we note the passing of William Jacob Holland. He was born August 16, 1848 on the Island of Jamaica in the West Indies. Beginning with an early training in theology his remarkable energy later extended over an unusually broad field of interest, including science, education, language, literature and art. His death, December 13, 1932, terminated a vigorous career as a naturalist and administrator. Doctor Holland's contributions in the fields of vertebrate paleontology and entomology have marked him as one of America's outstanding scientists, and his tireless efforts as an educator and as director of the Carnegie Museum have achieved enduring success.

His contributions to mammalian paleontology include studies of mastodonts, bison, oreodonts and preliminary accounts of the Pleistocene fauna discovered at Frankstown Cave. Particularly noteworthy is the monographic study of the Chalicotheroidea in which he was a collaborator.—C. Lewis Gazin.

ERNST HUBER

Ernst Huber was born at Winterthur, Switzerland, June 5, 1892. An early interest in natural history, encouraged by his parents, determined his career and he received his doctorate of philosophy in anatomy at the University of Zurich. After graduation he spent four years at his alma mater as first assistant to Georg Ruge, then joining the faculty of the Johns Hopkins Medical School as associate in anatomy. He was appointed associate professor in 1925, and died on October 24, 1932. During his scientific career he gained world wide recognition as an authority on the facial muscles of mammals. In addition he took a very active interest in the conservation of wild life of both Switzerland and the United States, and in the welfare of the American Indian. In Huber's composition was a touch of genius. A tireless worker, he had a remarkable knowledge of his subject and was a stimulating teacher. The individual position which he occupied in his scientific field will not be filled, nor will his place in the hearts of his associates.—A. BRAZIER HOWELL.

MEMBERSHIP

Anyone interested in any phase of mammalogy is eligible for membership in the American Society of Mammalogists, and if elected will receive the Society's official publication, the Journal of Mammalogy, quarterly. Name and address, with remittance of $3.00 for annual dues, may be sent to the Corresponding Secretary, or to any officer of the Society. Membership is dated from the nearest January, although formal election will not take place until the annual meeting of the Society following the receipt of application.